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Water Supply Projects in Connection with the New York State Barge Canal

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The construction of the New York State Barge Canal renders necessary a considerable extension for the water supply of the Rome summit level over and above the existing works for the present canal system. It is, of course, evident that with lock chambers of contents some 3½ times as great as with the old Erie Canal for the same lift and with a typical cross-sectional area for the improved prism 2½ times that of the existing waterway, the requirements throughout must be greatly enhanced and the problem serious indeed were it not for the canalization of natural streams in the Oswego and Mohawk watersheds and the introduction of a bountiful supply of Niagara River water conducted along grades in the long level carefully adjusted to conserve the flow and so to satisfy the severe demands of the "land line" throughout the western division. Even the amount of water necessary for the Rome summit level is very substantially less than if, as is the case with the corresponding level of the Erie Canal, it were designed to follow an elevation nearly 10 ft. higher and of a length 100 per cent. greater than the elevation and length of the Barge Canal as it is now being built.

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Emil Kuichling was first called upon to investigate the water-supply requirements and recommended for the summit level, besides the utilization of existing feeders and reservoirs, the construction of four new reservoirs (with the possible omission of one located on Nine Mile Creek) and the improvement of Cazenovia Lake to furnish additional storage. The Barge Canal Act provided for all these improvements except the Nine Mile Creek reservoir. But, although the capacity of the canal has since been increased, further study in the light of more complete data makes it appear that the two largest and most costly projects, namely, the Hinckley and Delta reservoirs—located on the West Canada Creek and the Mohawk River, respectively—will, at least for the present, suffice. These projects are also the least costly to the cubic foot stored if we except the Cazenovia Lake improvement, which would furnish but a small additional supply. Mr. Kuichling did, indeed, consider a site on the Oriskany Creek, but rejected it on account of the considerable depth of rock bottom at the site proposed for the dam so far as data then available indicated.

It is also to be noted that these reservoirs, by withholding water, snow and ice, will mitigate the floods which have hitherto devastated the lower Mohawk valley.

The Hinckley Project

The Hinckley project, which was let in September, 1910, to the Buffalo Dredging Co., at a contract price of $963,415, provides primarily for the construction of a dam about 3300 ft. long, extending from hill to hill across the valley of West Canada Creek just above the village of Hinckley. This is a modification of Mr. Kuichling's original plan, which contemplated a site below this town, necessitating its complete destruction. At Hinckley is located the timber dam of the Hinckley Fiber Co., the impounded waters of which are used in the company's logging and manufacturing operations, while the public water supply of the city of Utica is drawn from the same stream, somewhat above this point, through the pipes of the Utica Consolidated Water Co.

The lake or reservoir formed by the proposed dam will extend six to eight miles upstream and will cover, at crest level, a generally well timbered tract of 4.46 sq.miles. It will, moreover, flood numerous farms and dwellings and inundate portions of three villages. The capacity is estimated to be, at a water-surface elevation of 1225, 3,445,000,000 cu.ft., and at elev. 1232, about 4,440,000,000 cu.ft., so that the average depth is about 28 ft. Several miles of new highways must be constructed to replace seven miles abandoned, but aside from this and the extensive work of clearing and the removal of buildings, the large dam is the only considerable work involved.

The flow of the river or creek at the site selected for the structure, ranges

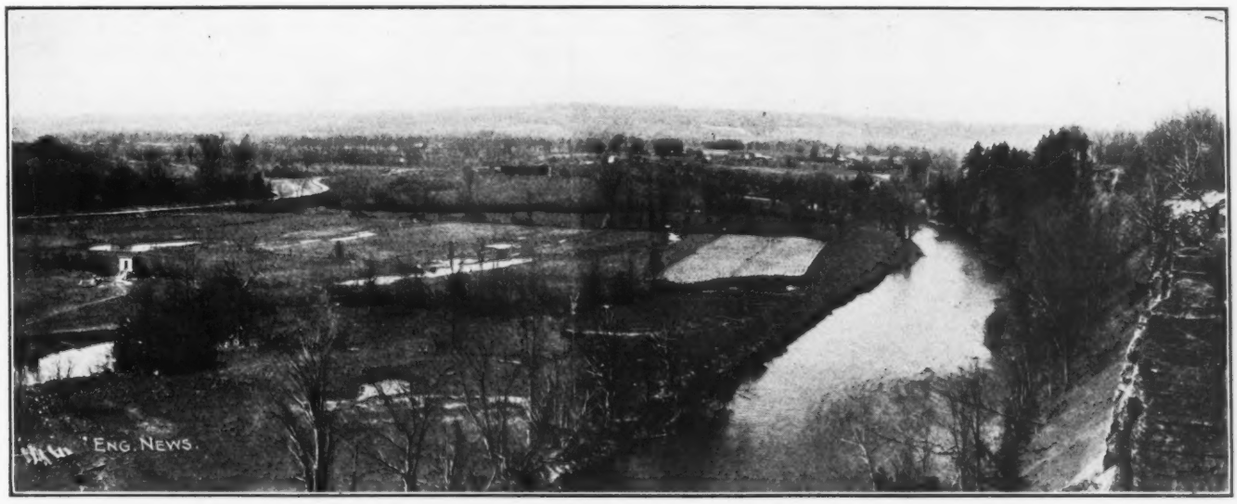

Fig. 1. Site of Delta Dam; View Looking Upstream Taken Before Construction Commenced

from 150 to about 40,000 cu.ft. per sec.; and, with the gorge only 200 ft. at the bottom and eroded 30 ft. or more into the firm, enduring Trenton limestone, the problem of handling the river is somewhat difficult, although the foundation material is excellent. In view of the conditions in the river channel, it was determined to build at this point a 400-ft. masonry spillway and gatehouses,

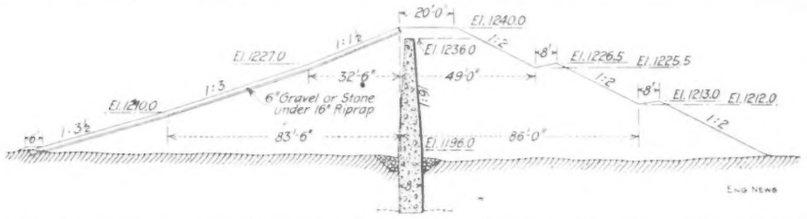

FIG. 2. SECTION OF THE HINCKLEY DAM, WATER SUPPLY, NEW YORK STATE BARGE CANAL

the crest elevation being fixed at 1225, or 78 ft. above the lowest rock in the river bed. Since, however, the adjoining plain extends about one-half mile to the southerly hills at a general elevation of about 20 ft. above rock surface, it was further decided to terminate this masonry section in long abutments, and for the remainder of its length the dam was designed as an earth structure, the core-wall only being constructed of concrete and extending to a rock foundation.

The Hinckley spillway, which is 400 ft. long, was computed to carry an 8-ft. head of water, equivalent to about 33,000 cu.ft. per sec. with sluice gates closed. The Hinckley drainage area is about 372 sq.miles and the discharge per sq.mile therefore would be over 88 cu.ft. per sec. on this basis. The structure will carry, however, a very much greater discharge with comparative safety. Moreover, it is intended by proper regulation to keep the maximum discharge down to about 19,000 cu.ft. per sec. (about 16,000 over the crest).

The general height of the earth dam will be about 40 ft., and the maximum height nearly 50 ft. Its top width, as shown on the cross-section (Fig. 2), is 20 ft., and its upstream slopes, varying from 1 on 2½ to 1 on 3½, are protected with 16 in. of riprap, while downstream the 1 on 2 slopes carry two 8-ft. bermes with longitudinal gutters leading to paved lateral ditches placed 300 ft. apart and themselves conducting the drainage over a concrete apron at the foot of the slope, thence to an intercepting ditch extending along the foot of this slope and emptying into a small watercourse in the vicinity. It was expected that the earth portion (contractor's price for which is 28c. per cu.yd. of embankment besides the excavation price of 46c.) could be hydraulically built from a pit in the neighboring hillside by the use of pump, jet and flume, but the contractor decided to place it in the ordinary manner, merely flushing it in place. The material on the site is generally composed of sand and cobbles, sometimes mixed with clay, underlying sandy loam or muck. Pure clay is not found extensively within two miles. Construction sand is abundant and cobbles for crushing are plentiful.

The principal gatehouse contains four 60-in. cast-iron pipes passing through the dam on a skew (controlled at the upper end by 5-ft. square sluice gates and also by stop-planks) emerging through a lower gate-chamber, where they are provided with 48-in. gate valves, onto a long concrete apron, whence the effluent escapes into the river. The most northerly 60-in. pipe is to be tapped for a 30-in. pipe for use, if desired, as a supply to the Hinckley Fiber Co. South of the spillway there is provided a second gatehouse containing two 42-in. pipes for the use of the Utica Consolidated Water Co. This gatehouse is equipped with facilities for drawing water at three stages about 30 ft. apart. The two lower openings, corresponding with either one of the 42-in. pipes, are controlled by sluice-gates, protected by steel screens with raking platforms, and the upper opening is controlled by stop-planks, while all three may be cut off by stop-planks in emergency and all three feed into an interior well discharging at its base into the 42-in. pipe, subject only to the control of a circular sluice-gate located at this point. The heavier stop-planks in connection with this dam are designed to be built up of white-oak sticks fastened between steel I-beams in sections of convenient size, each provided with bronze wheels to reduce sliding friction in both directions, and handled by lifters somewhat improved over those heretofore used. All sluice-gates and stop-planks are manipulated from rooms concealed within the outlines of the main structure, accessible by stairways leading down from the top of the dam and lighted through movable skylights. An attractive reënforced-concrete railing was originally designed for the top of the dam and elsewhere, but later abandoned in favor of the plainer wrought-iron pipe railing (see Fig. 2 for comparative sections).

Legislation has been at times attempted permitting of the adaptation of these designs to the development of water power from the Hinckley reservoir and possibly of a greater storage than is now proposed, with the same object in view; but this aim has been defeated and the existing laws have been interpreted to preclude additional outlay for the sake of power development.

The dam will contain about 600,000 cu.yd. of embankment and 110,000 cu.yd. of concrete and cyclopean masonry, a portion of this embankment and considerable of the core-wall having been already placed.

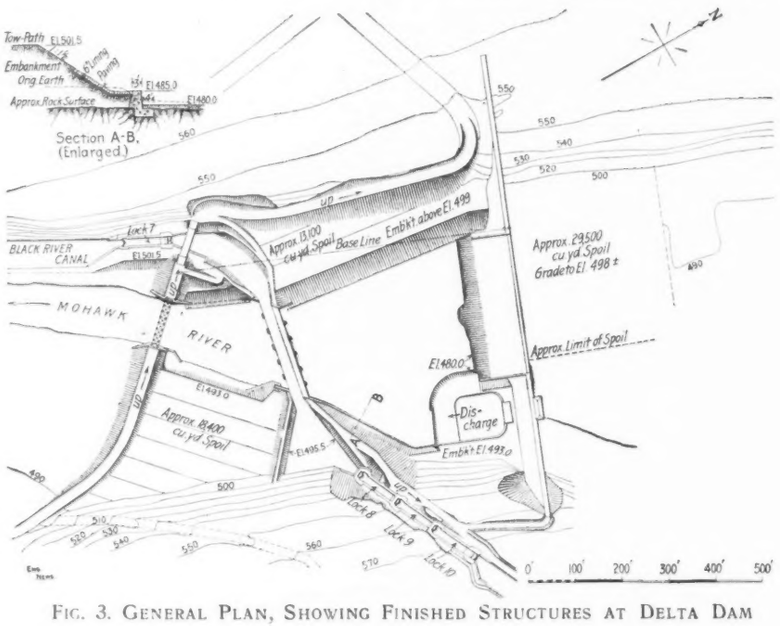

FIG. 3. GENERAL PLAN, SHOWING FINISHED STRUCTURES AT DELTA DAM

THE TRENTON FALLS FEEDER

At the village of Trenton Falls, five miles below Hinckley, and also just below the power house of the Utica Gas and Electric Co., the original plans provided a dam with a 275-ft. length of spillway across West Canada Creek in place of

an old existing timber structure, and provided also for diverting a maximum flow of 350 cu.ft. per sec. into a channel to be constructed for 5.75 miles across the divide and emptying into Nine Mile Creek, which would then convey the water to the summit level of the new canal. However, as actually let during Dec., 1910, Contract No. 51 does not provide for a diverting dam, which, it was thought, could be readily constructed when the existing dam would no longer serve that purpose. It provides, however, merely for the channel and headworks with a reinforced-concrete siphon under Cincinnatus Creek, several culverts and bridges and a reinforced-concrete flume at the outlet—all at a contract price of $389,842.

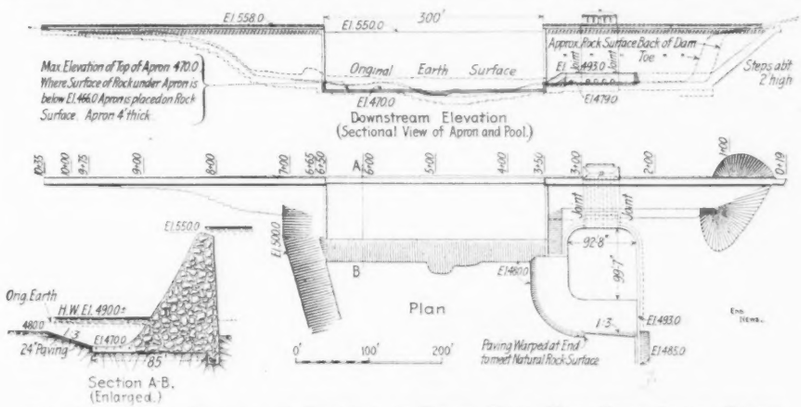

FIG. 1. GENERAL PLANS AND DETAILS OF DELTA DAM, NEW YORK STATE BARGE CANAL

Two Browning excavators have done considerable work on this contract during the season of 1911, and the outlet flume has also been constructed.

THE DELTA PROJECT

The second great water-supply project, the Delta reservoir, is about completed. This project utilizes a drainage area of approximately 137 sq. miles, situated, like the Hinckley drainage basin, in the general locality of the summit of precipitation of New York State. With the crest of the dam as built at elevation 550, it furnishes a storage capacity of 2,750,000,000 cu.ft., and at probable high water will contain about 3,000,000,000 cu.ft. With an average depth of some 23 ft., it attains a maximum of 70 ft. in depth of water at the dam. It is probable that the storage will cost about $75 per million gallons, of which $25 is chargeable to land takings covering an area of about 4.8 sq. miles. Of this area the reservoir will occupy at crest level about 4⅓ sq. miles.

The principal part of the work of construction is included in Barge Canal Contract No. 55, let in Oct., 1908, to Arthur McMullen, of New York, the lowest of twelve bidders. His contract, with alterations, amounts to $945,840, on the basis of the quantities of the preliminary estimate, but this does not include the relocation of several highways and the removal of bodies from burial grounds to be submerged.

DESCRIPTION OF THE LOCALITY—Lying about 4½ miles north of Rome, the site of the Delta dam is the lower end of a rock-walled gorge or water-gap 600 ft. wide at the bottom, along the easterly side of which the Mohawk River flows due South against precipitous cliffs known as the "Palisades." Immediately above this water-gap the river channel swings through an angle of 90° in its course and the valley widens in a westerly direction to its maximum width of two miles and gradually tapers to the northward, so that the proposed reservoir will occupy a triangular depression lying between high hills on two sides and a far-reaching plateau of moderate elevation on the south. From this triangular valley, resembling in shape the Greek letter Δ, the village of fifty houses, formerly occupying a position at the southwesterly vertex, took its name.

Near the northerly vertex, four miles above the dam, the village of Westernville remains almost intact, overlooking the valley; but the two hundred or more buildings, including the hamlet of Delta, and several burying grounds, also ten miles of dirt roads, two miles of the Black River Canal with seven locks and an aqueduct, nearly 3000 acres of territory about one-tenth wooded and for the remainder largely composed of fertile and cultivated bottomlands—all of these have been sacrificed as a consequence of the inundation. The four locks, and aqueduct in connection with the relocated canal line, and one of the shorter relocated highways are shown in Fig. 3.

The terraced marginal slopes especially to the south, the water-gap at the "Palisades" serving as an outlet for the river, a buried gorge in the rock surface uncovered at the site of the dam and large pot-holes disclosed in the excavation for the aqueduct below the dam denote the action of glacial and post-glacial waters in this vicinity, and the new lake will therefore, in a measure, merely reproduce ancient conditions.

CHARACTER OF BED ROCK—Everywhere in the locality of the reservoir the rock is a Hudson River shale peculiarly subject to rapid and complete disintegration under the action of the weather, as indicated by the exposed or thinly covered side walls of the gorge and the frequent talus accumulating at the base of the cliffs (Fig. 3). In the valley, however, underneath a protecting blanket of earth, the rock presents a relatively firm and compact surface without open seams, but is no less susceptible to speedy decomposition upon exposure. Thus, although all masonry structures could be economically founded on rock, it was necessary to recognize the perishable character of the rock in all designs.

PRELIMINARY INVESTIGATIONS — Mr. Kuichling in 1900 made hasty surveys, but for hydrographic data was obliged to rely principally on the rainfall statistics and relation of run-off to rainfall as determinated from other streams. Afterward a flow-line traverse and a right-of-way traverse were run around the reservoir and adjusted to serve as a basis for the subsequent topographical and appropriation surveys. No primary triangulation was employed, although considerable confusion and inconvenience resulted from this fact. In the year 1905 about 17,000 stadia shots were taken based on levels run from the Erie Canal, and an area of nine square miles was mapped with 2-ft. contours. Gaging stations were also established, and wash-drill borings—at first about 10 ft. and later some 30 ft. apart at the site of the dam, numerous rod soundings and about nine calyx-drill borings were taken, and test-pits excavated as required.

Mr. Kuichling first suggested elevation 540 as the crest elevation, but 550 was ultimately chosen. The bounding plateau on the south would have permitted at least a 20-ft. greater height, but would not have increased the capacity enough, in the opinion of the engineers, to compensate for a serious encroachment on the flourishing village of Westernville, now just outside the flooded area. Moreover, it was estimated that, with a crest level at elev. 550, 151 cu.ft. per sec. (a supply in excess of the probable requirements from this source) could always be supplied to the canal throughout the season of navigation, and a flow of 37 cu.ft. per sec. perpetually maintained in the river without emptying the reservoir except for one year of those recorded, and that year one of the very dry series of 1837, 1838 and 1839.

The top of the spillway was designed with reference to experimental data. Consideration was given to lengths for the overflow portion varying from 300 to 400 ft., and the former figure was finally adopted.

For the later investigation, flood data as follows were available: A flood of August, 1904, lasting five days and indicating a maximum of about 8000 cu.ft. per sec., and a spring flood of 1905, continuing for 15 days, but reaching only a maximum discharge of 6000 cu.ft. per sec. In connection with this information, it was decided that normally the reservoir could be drawn down during the winter season, leaving its entire capacity to alleviate flood conditions in the spring and obviating ice action during high water, while the gates would be so regulated as to prevent a discharge into the stream exceeding 2500 cu.ft. per sec. in summer, or 2600 cu.ft. per sec. during the winter season. Hydraulic studies and diagrams, however, indicated that with these floods no greater height than 3 ft. on the crest would in any event be possible, and 1½ ft. would be the probable maximum under assumptions above stated. The flow-line contour was fixed at elev. 555, however, thus covering backwater and wave action.

FIG. 5. STEPPED ROCK FOUNDATION FOR THE DELTA DAM

TYPE AND CROSS-SECTION OF DAM—In considering the kind of dam to be built, the Ambursen reinforced-concrete type was discussed, and, aside from the illegality of using a patented construction on public work in the state, it was thought that not a sufficient sum would be saved to warrant a departure from the conservative practice. The gravity type was therefore adopted (Figs. 3 and 4).

The usual studies for stability were made. A dozen sections were computed and the twelfth was subsequently modified somewhat. Each computation assumed concrete weighing 150 lb. per cu.ft. and an extreme head of 5 ft. on the crest. Mr. Kuichling employed a section modified from the Croton dam, which, with comparative studies of other noteworthy structures, served as a basis for later investigation under the direction at different times of Wm. R. Hill, Glenn D. Holmes, D. A. Watt, and others.

One of the sections contemplated a highway on top of the structure, but the Advisory Board of Consulting Engineers rejected this arrangement on account of the danger to travel in stormy weather and the excessive width (over 15 ft.) required at the top, and the relocated highway was, therefore, built across the valley below the dam. Studies were even made for a design to carry the relocated Black River Canal across on the dam, but these were also rejected.

Although computations for the section of the main dam were based on a depth of 100 ft. below crest level, as a matter of fact, since the spillway occupies the deeper portion of the valley and has a somewhat heavier section, there is no section of the above type, as actually built, extending more than about 80 ft. below the crest level. Moreover, the foundations are generally carried at least 6 ft. into rock and a masonry cut-off, approximately 8x8 ft. beneath the upstream edge, still further prevents percolation and secures the structure against the consequences of erosion and the probability of upward pressure.

As already stated, there were some late, though minor modifications in the section. The last feature added consists in a frieze of arches introduced for architectural appearance immediately below the coping and in conjunction with the diminution of the thickness of the section at this point undertaken for the purpose of increasing the overhang and its shadow effect (Fig. 6).

DESIGN OF SPILLWAY—The design of the spillway was attended first with difficulties of alignment. In order to avoid a very high overfall with a structure founded upon rock subject to rapid disintegration upon exposure, the first plans contemplated a spillway located upon the somewhat gradually sloping westerly hillside and nearly at right angles to the main structure, thus reducing the spillway to an insignificant height, while the overflow was to be carried for some distance along the rock surface before being permitted to drop over a rock slope 10 or 15 ft. high, forming the side wall of a steeply sloping waste channel. This waste channel traversed the contour of the hillside in cut, passed beneath a reinforced-concrete arch of about 61-ft. span on the skew (provided to furnish a roadway from the main structure to the bank) and eventually turned through a somewhat sharp curve into the river channel at a point several hundred feet down stream from the dam. The layout and grades for this channel were somewhat complicated in view of its high velocities, and for determining the effect of centrifugal force on the water surface throughout the curved portion experiments were performed on a celluloid model.

It was thought that, since an overflow would occur only at rare intervals, this design would safeguard the structure against undermining, but the design was finally rejected in favor of a high spillway in the center of the main structure discharging into a pool. Mr. Kuichling had suggested an auxiliary dam to form a water cushion below the reservoir wall itself. Instead, however, the apron, 4 ft. thick, was carried down to elev. 466, or deeper if necessary in order to reach rock foundation, and the 1 to 3 slope extending up from the toe of this apron to elev. 480, or the normal river bottom to which the valley below the dam has been leveled, is protected with 24-in. paving. Thus a pool always 10 ft. or more in depth will be maintained as a water cushion. The irregularity of the apron due to the varying depth of rock foundation would be in any event concealed by the pool, but conditions were actually found to permit of a symmetrical construction, the two center 30-ft. sections of the spillway apron being carried down to about elev. 461, and the curve between the apron surface and the downstream face thrown forward correspondingly. The adjoining sections on each side were then made to vary uniformly between the two profiles by tilting the curved forms for the steeper portion and working a straight-edge between the adjoining sections as templates or screeds to form the lower part of the apron.

It was at first thought advisable to break the effect of the somewhat extra-

ordinary fall of 70 ft. from crest to pool surface, by the use of steps. An early study contemplated a rise equal to the depth of a single course of masonry, but later plans provided steps varying from 5 to 9 ft. in depth as this depth was deemed essential in order to retard the velocity of the falling sheet. As for surface material the expense of ashlar masonry was deemed prohibitory and ultimately concrete blocks were rejected in favor of monolithic cyclopean masonry throughout, notwithstanding the elimination of difficult form work possible through the use of surface blocks.

As the top of the spillway profile was for independent reasons heavier than that of the ordinary theoretical profile already considered, it seemed advisable to introduce a curve to conceal the angle formed at the junction (well below the crest) with the theoretical profile. The resulting profile could be so closely replaced by a long curve of 430 ft. radius and the spillway surface was to be exposed so much of the time that the substitution of such a curve was carried into effect. Although it was criticized as an unnecessary complication, no difficulty was experienced in constructing this curve, and indeed the contractor failed to take advantage of the privilege accorded him of using plane rather than curved forms. Moreover, it appears to the author from inspection, since the spillway was completed, that the curve noticeably improves the appearance of the structure.

ALIGNMENT OF DAM—A curved alignment for the dam was originally regarded with favor, and an 800-ft. radius for the upstream toe was selected. As the chief advantage in the curve consisted in its artistic merit (since the structure would be far too long in respect to its height to permit of any allowance for arch action in the calculations) this plan was finally abandoned in connection with the change of spillway into the middle of the valley, and the straight location adopted, resulting in a saving of material and somewhat less of complication in design and building.

An earth section was also designed for a short distance at the west end, but finally abandoned in favor of all-masonry construction.

The dam is actually about 1100 ft. long, 100 ft. high between crest level and lowest rock foundation and will contain over 90,000 cu.yd. of masonry.

PIPES AND GATEHOUSES—A study of several sizes and combinations of discharge pipes for passing the normal flow of the Mohawk River through the dam and regulating the height of water in the reservoir was made. The costs and carrying capacities of these combinations were compared and as a result, four 60-in. cast-iron pipes were chosen, one of which was, as a safeguard, assumed to be ineffective throughout all computations. These pipes were arranged to be straight in plan, but otherwise similar to those already described for the north gatehouse of the Hinckley dam. The gatehouse superstructure, however, was built, with concrete walls and red tile roof, above instead of within the profile of the dam itself. The outlet, also, required unusual precautions to avoid scour from the discharge when under its 70-ft. maximum head. A concrete pool about 90 ft. by 100 ft. was designed, therefore, just below the lower gate-chamber, with a 150-ft. length of spillway standing 6 ft. high above the concrete floor, for discharging the effluent at a reduced velocity upon the native rock.

The original computations assumed a coefficient and on that basis determined the loss of head at inlet, at the 48-in. valve and that due to friction, the process being repeated with the revised coefficient until the final value was found which would make the proper correction for total loss of head. This final value was about 0.71, and the pipes were found capable of discharging about 950 cu.ft. per sec. each, as a maximum.

EXPANSION JOINTS—Among the numerous details of design for the dam, should be mentioned the arrangement of expansion joints, fixed as 30 ft. apart in general, with vertical, V-shaped keyways formed in the concrete and voids serving as drains, 8 in. (Fig. 7) square in cross-section, parallel with and near the downstream face, designed to intercept any leakage which might cause discoloration of the surface and convey such leakage to an outlet below ground or pool level. Actually it proved difficult or impossible to prevent clogging of these drains with grout leaking from beneath the forms above, notwithstanding that they were frequently flushed out during construction.

FOUNDATION PROBLEMS—The foundation problems at the dam did not prove difficult. The old Black River Canal was used for supplies and the dam built beneath and around it. The river was maintained in its natural rock channel, on the east side of the valley at the foot of the "Palisades," throughout the early part of the work, then, by means of a cofferdam, confined to the easterly portion of this natural channel. Later it was deflected to a notch in the structure already built so as to complete the unfinished portion. Provision was made in the specifications for drilling and forcing grout into seams encountered in the rock, but no considerable seams developed, although some difficulty was experienced in preventing shattering of the shale below grade and outside the lines. In fact, the 8x8-ft. cut-off, which was not channeled, was actually built much wider at the top and somewhat shallower by reason of this difficulty. The water encountered was small in amount and, where unavoidable, was conveyed during construction through inverted V-shaped troughs underneath the concrete to an outlet where possible, otherwise to a low sump, boxed over, whence suction and grouting pipes were carried up through the structure (Fig. 5).

FORMS—In construction, the forms at joints were built in permanent sections about 22 ft. long by 20 ft. high, and no serious difficulty was experienced in holding these forms, when raised, by bolts left in the concrete already built, by steel tie-bars with turnbuckles and by timber struts to be removed as the forms were filled. Considerable difficulty was experienced, however, at the junction of the horizontal apron and the downstream batter in maintaining the forms against the enormous upward pressure developed, as

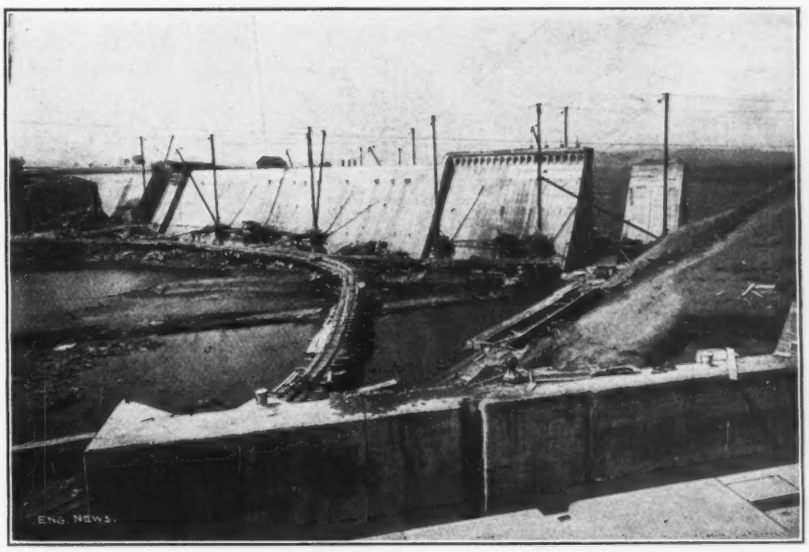

FIG. 6. VIEW OF PARTLY COMPLETED DELTA DAM

a slight deflection of the form between supports permitted the flow of water beneath the lumber and consequent disfiguration of the masonry surface. The 2-in. pine lagging was largely imported, but otherwise most of the lumber used on the contract was obtained from the clearing.

MINOR STRUCTURES AND CANAL RELOCATION—The smaller structures consisted principally of the aqueduct and the four locks, the latter each 15 ft. wide and about 92 ft. long in the clear, three of these being of 20.6-ft. lift each and combined in a flight, and the remaining one, Lock No. 7, of 12.1 ft. lift, isolated and provided with approach walls carried a foot below grade and supported on and tied to piers extending to rock—a design

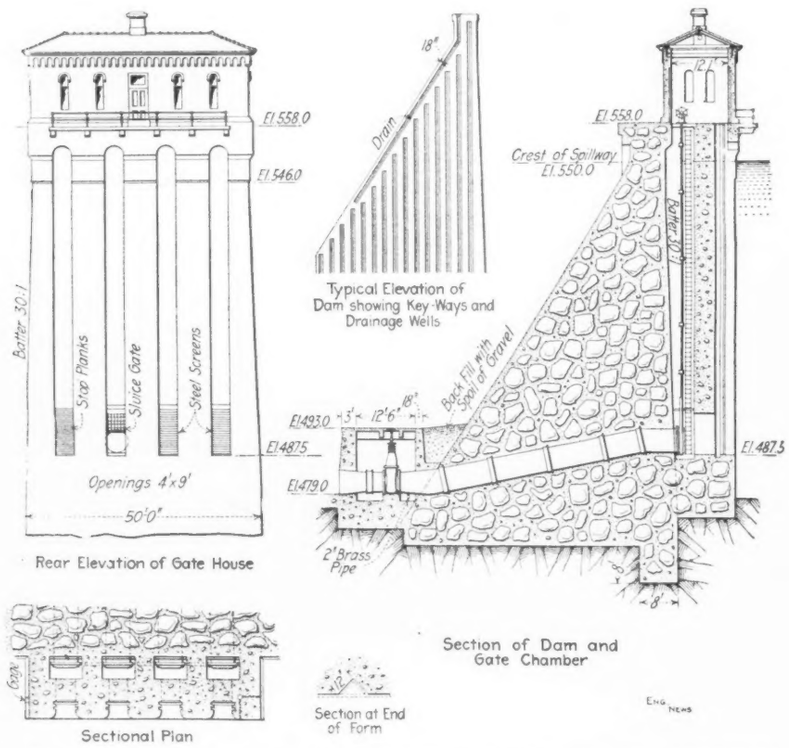

FIG. 7. DETAILS OF GATE-HOUSE AND KEYWAYS AT EXPANSION JOINTS OF DELTA DAM

very generally adopted on the barge canal in place of the solid wall throughout. Culverts through the walls generally serve as by-passes. The two uppermost gates are of the tumble-gate design employed largely on the old state canals; the others are miter gates. Instead of a gravity wall, the designs contemplated a 4-ft. width of section, where the wall could be built against rock, tied by deformed bars 5 ft. 6 in. long and 1 sq.in. in section, grouted into the channeled face of the rock, with provision for drainage behind the walls. Attempts were made to test experimental rods, which developed ample strength. The application of the plan was successful in the case of a 10-ft. cut, as in Lock No. 7, but in the flight of locks, where the cut was 30 to 40 ft. and had to be channeled in several lifts, the shale caved badly and the design was changed to admit of walls of the gravity type. Lock No. 7 was originally placed on one side of the existing canal mainly to permit construction to progress during the open season, the boats passing around the lock meanwhile. Actually, however, this lock was built during the spring of 1910 and used in connection with the old canal by a temporary arrangement of the upper sills and gate at elevations about 18 in. lower than those required for the final arrangement. There are now being introduced in the section of the dam left open for the passage of the old canal two 30-in. pipes controlled by wooden sluice gates above and by valves in a chamber below the dam. These pipes unite in a single 30-in. pipe emptying into the new canal, just below Lock No. 7, as a substitute in some measure for the Delta feeder, which the reservoir obliterates.

As already stated, an early study was made for carrying the canal across the valley on the dam. Another suggestion contemplated a pool in the river below the dam and connection therewith from the canal on both sides. The aqueduct, finally decided upon, was at first patterned after the existing structure which it replaces—masonry abutments and piers carrying a wooden trunk—but this was rejected as being too perishable. A concrete arch was also considered, but a reinforced-concrete truck of 23-ft. interior width and about 208 ft. long, supported on five concrete piers and two abutments, was ultimately built and provided with a concrete towing path at the side and a 50-ft. length of spillway (Figs. 8 and 9). At each joint a strip of lead was provided for water-tightness extending into the concrete on both sides of the joint and folded over between, so as to admit of hinge action to cover the expansion and contraction in the masonry.

Difficulties were encountered in excavating the foundations of the center piers of the aqueduct. The borings were deceptive on account of boulders, and the rock surface proved very irregular, extending, in part, 30 ft. below river bottom, while the width of excavation of only about 10 ft. and the seepage from the river under the cribwork of the cofferdam and through the boulders and beneath the sheet piling retarded operations seriously, but the structure was, nevertheless, carried down to rock foundation except for small areas which it was assumed the concrete would bridge over (an early design for one of the piers had, in fact, contemplated an entire gravel foundation protected by heavy paving).

The small "change" bridge carrying the towing path as well as the highway across the canal, was at first designed of wood, but revised for steel, with the object of greater permanency. Each of its abutments consists of two independent square concrete piers and the reinforced slab approaches follow the characteristic barge-canal design. For the river bridge the old steel superstructure is raised and realigned on abutments—one entirely new and the other utilizing a wing of the old structure.

The 1½-mile level of canal alignment above the locks is complicated by numerous curves, several being as sharp as 20° (one below the locks is 30°). It was provided that the standard width of 30 ft. at 12 in. above bottom grade should be increased on a curve by twice the middle ordinate of a 100-ft. chord. This rule, however, was further complicated by curves of less than 100 ft., reversed curves and points of warping between earth and rock slopes and between cut and fill and widths were determined largely by the aid of graphical methods and then tabulated.

The 25-ft. depth of rock cutting 2500 ft. long was readily done by a 70-ton steam shovel with little blasting and an extensive borrow of earth for the long and heavy side-hill embankment was similarly excavated at a maximum rate of 1250 cu.yd. per day. Much of the rock from the cutting was spoiled alongside this embankment, strengthening it, serving as a protection from the wash of the reservoir and being utilized later for the highway relocation. Considerable rock was also deposited in a ravine, intersect-

ing the canal line, 80 ft. deep and extending 50 ft. below canal bottom. Original studies provided more heroic treatment for this crossing, but it was considered sufficient to construct the prism embankment on this rock spoil, after a year's settlement, paving the exposed slopes and providing a culvert to extend beneath the canal and founded on a bench in the hillside.

The shorter embankments adjoining structures were built with 2-ft. corewalls of puddle. The canal requirements relative to compacting in 9- to 15-in. layers were enforced, but in one instance where the material was so fluid as to forbid hand manipulation, a drag scraper was used, attached to a cable propelled by a stationary engine on one bank and passed around a pulley block on the other bank, working in such a manner as to draw the scraper loaded into place, then by reversing the direction of pull, to swing over the bale, thereby locking it, by reversing again, to dump the load and by again reversing to withdraw for adjustment and reloading. This process with material of such constituency was deemed to provide sufficient manipulation.

During the past summer the relocated canal has been filled above the locks to a depth of 5 ft. (the prescribed depth is 4 ft.) and, except for difficulty at the junction with the old prism—due, it is understood, to leaving part of an old abutment in place in the new embankment—and in spite of careful economy in using material from the excavation to avoid excessive borrow, and notwithstanding that numerous streams are intercepted by this level of the canal, no breaks have occurred, although there is seepage beneath or through some of the heavier embankments.

CONSTRUCTION METHODS AND PLANT—The dam was started with the use of tracks and rows of derricks (each of 75-ft. boom and 80-ft. mast, lumber being of Oregon pine) elevated on piles and crossing the valley to the north and to the south of the structure. Later the derricks were moved on to platforms attached to bolts embedded in the finished concrete. Although the contractor had elsewhere a Lidgerwood cableway of 1000-ft. span, he regarded it as too slow for use in excavating and concrete work and hardly worth while for general transportation, especially as the materials during most of the work were to arrive by the old canal, located in the valley.

All-told, the contractor had on the site probably $100,000 worth of plant, including a maximum of 3 miles of single track, 6 locomotives, 25 stationary engines, 18 derricks, 9 boilers (ranging from 30 to 125 hp.), 2 steam shovels, a channeler, also machine, carpenter, blacksmith and pipe-fitting shops, a sawmill, etc. One concrete mixer only was used, located upstream from the dam along the towing path of the old canal. It was a 5-ft. cube mixer which maintained an average 8-hour output of 154 cu.yd. during the active season of 1910 and 190 cu.yd. in 1911, and reached a maximum daily output of about 260 cu.yd. Two hundred and sixty cu.yd. of concrete, however, represent nearly 460 cu.yd. of cyclopean masonry, inasmuch as the large stones occupy about 43% of the total volume of masonry as nearly as could be ascertained by comparison of monthly estimates of quantities with batches delivered. This percentage (somewhat larger than is usually obtained) is to be accounted for by the very regular shape in which the limestone quarried, explosives not being required for the purpose. The specifications stipulated 6 in. clearance between stones and 12 in. clearance at the face of the concrete.

The cyclopean stone, which was always cleaned with a jet, but seldom required scrubbing, was boated about 24 miles, from the Sugar River quarries above Boonville, operated by the contractor for the time being. The broken stone (also limestone) was shipped for a distance of 17 miles, or from the Hough quarry, opened for the purpose by the contractor and equipped with an 800-ft. cableway, a gyratory crusher, etc. At first without, and later with, the requirement of screening to eliminate clay lumps and shale

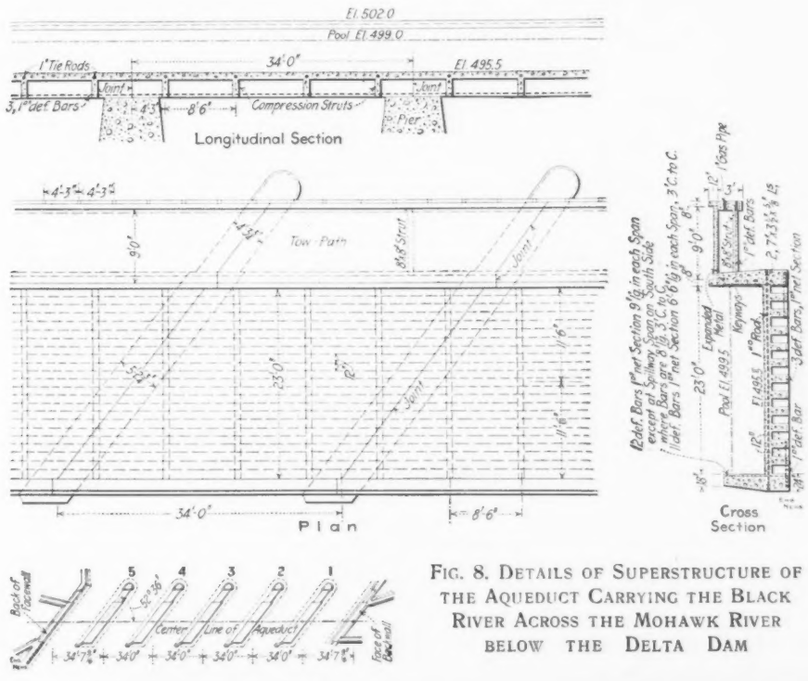

FIG. 8. DETAILS OF SUPERSTRUCTURE OF THE AQUEDUCT CARRYING THE BLACK RIVER ACROSS THE MOHAWK RIVER BELOW THE DELTA DAM

FIG. 9. VIEW OF THE AQUEDUCT BELOW DELTA DAM

(In right background may be seen flight of locks carrying the Black River Canal around the dam.)

cobbles, the sand was boated from the contractor's sand-pit, located 6 miles upstream. For transportation purposes a fleet of 30 to 40 barges, each of about 80-tons capacity, was built and put in service on the canal. Surplus materials were stored on the site for winter use. A storage house for cement, which came by canal, was erected near the mixer with a capacity of 40,000 bbl. Bottom-dump buckets were generally employed for transportation from the mixer, capable of carrying about 2 cu.yd. measured in final position, the standard type, nearly cubical in shape, but with sloping sides, being adapted best to the larger structures and a longer box with double instead of single doors being used especially to dump in narrow forms.

It was not deemed necessary to rub down or treat in any way the upstream face of the dam, as it presented a sufficiently good appearance without so doing. The downstream face was rubbed with carborundum, though with far less pains than in the case of the smaller structures.

Some slight difficulty was experienced, especially at first, with the formation of laitance. Conditions were improved, however, by using as dry concrete as would suffice to bed the large stones, by carefully keeping surplus water from the face of the structure and by installing tanks for measuring the amount of water used at the mixer instead of allowing this to be governed by a laborer whose duty it was to regulate the supply-pipe valve according to the number of turns of the cube.

The settlement for and management of appropriated lands has required extensive attention. The appraisals and settlements are handled by the special appraiser for the Barge Canal, except claims which are brought before the State Court (now Board) of Claims. As a matter of fact, the rights of the owner cease upon service of papers. The buildings and timber go to the contractor for occupancy and removal, but no one presumably could legally harvest the crops. In fact, however, the territory is not policed, and the contractor has not molested land except as needed for construction purposes, so that there has been, in many cases, nothing to prevent the harvesting of crops by former owners—often to their material relief, without expense to the state.

The entire Barge Canal and accessories are now being constructed under the direction of J. A. Bensel, state engineer, and Alex. E. Kastl, special deputy state engineer. Edwin Styring is at the head of the middle division, and L. C. Hulburd of the water-supply residency. The author was formerly assistant engineer in immediate charge of the Delta project and was succeeded by C. W. Costello. C. L. Bannister is in local charge at Hinckley. The contract for the Delta project is held by Arthur MacMullen, of New York, and of the Hinckley project by the Buffalo Dredging Co.

Meeting of the Headings of the Catskill Water Supply Tunnel

We reproduce herewith a flashlight photograph of the party which celebrated the "holing through" of the Catskill water-supply tunnel under the Hudson River opposite Storm King Mountain, on Jan. 30. The photograph was taken with the party assembled at the point where the advance heading from the east and west shafts were joined, after Mayor Gaynor had closed the switch which fired a final blast.

MEETING OF THE HEADINGS OF THE CATSKILL WATER SUPPLY TUNNEL, JAN. 30, 1912

The photograph is of especial interest as it shows something as to the general character of the rock which underlies the Hudson River at this point at a depth of 1100 ft.

Difficulty with Fine Argillaceous Sand in water from a deep bored well at Skegness was described in a paper read before the Institution of Water Engineers in London, England, not long ago, the paper being presented by Percy Griffith. The well was a trial or test bore, which yielded so copiously that it was decided to try to retain it for permanent use. This trial well was carried down with 10-in. tubes to a depth of 50 ft. from the surface, and then with 8-in. tubes to a depth of 186 ft., the 8-in. tubing being continuous for the whole 186 ft. Below the 186-ft. level, "the boring was continued with a 6½-in. cylindrical tool (working in loose shot) to a depth of 252 ft. from the surface," penetrating for 20 ft. into what is locally known as the Kimmeridge clay. On April 6, 1908, pumping from the well began. On July 3 the water was found to have "a thick, milky-white appearance," which led to the temporary abandonment of the use of the water. Three Bell pressure filters were installed, but it is found that when any quantity of clay was present in the water the filters would be choked, so as to make washing necessary once an hour or less. The use of sulphate of alumina, while aiding in clarification, increased the necessary frequency of washing and thus was of no avail. An analysis of the sandy matter deposited on the filters showed it to be of "fine gray sand, with occasional fragments of very sandy clay and occasional nodules o fblack hard rock." It was first thought that this clay and material came from the clay bed at the bottom of the boring, but it was subsequently concluded that instead it came from "the band of rock in which the 8-in. bore tubes were bedded, thus allowing the clay from above the two ends to fall into the open boring." The difficulty was finally met by sinking a second well, 12 in. in minimum diameter and 210 ft. deep, not far from the first, and abandoning the first well. Mr. Griffith stated that a part of the trouble with sand from the original well may have been due to the high velocity of the water, which was drawn at the rate of about 21,000 U. S. gal. per hour through the 8-in. tube. The filters were retained for use at times of occasional discoloration by fine sand, should such occur in future. Mr. Griffith's paper, which describes other features of the new water-works of Skegness, was printed in the London "Surveyor" for Dec. 22, 1911.

An Outgrown Sewage-Purification Plant at Madison, Wis.*

By James Mackin†

The sewage-disposal plant of Madison, Wis., consists of two septic tanks, 11 cinder filter beds and a sludge bed. Each tank has a cubical capacity of 200,000 gal. The filter beds have an area of about 1½ acres. The tanks are composed of concrete and have a tar and gravel roof, and were designed to care for 1,000,000 gal. of sewage in 24 hours. The filter beds were also designed to care for that amount of sewage. The plant was built in 1901. The capacity of the plant was reached in 1903. From that time to the present the amount of sewage cared for has greatly increased, and last year the average amount cared for in 24 hours was 2,105,000 gal., or more than twice the amount the plant was designed to handle. The velocity of the sewage through the tanks is doubled and the accumulation of sludge is much greater than it was when the plant was treating the amount of sewage for which it was designed. As the flow of sewage fluctuates during different hours of the day, conditions are worse than would seem from taking the average flow in 24 hours into consideration.

From 8 a.m. to 6 p.m. an 8-in. centrifugal pump, with a capacity of 3,000,000 gal. per 24 hours, is used to elevate the sewage into the tanks. During that part of the day the velocity of the sewage through the tank is three times what it should be. From 6 p.m. to 8 a.m. a 6-in. centrifugal pump is used, with a capacity of 1,700,000 gal. per 24 hours.

On account of the short settling period the efficiency of the tanks is greatly reduced and the sludge has to be removed much oftener than if the settling period were longer. We now remove the sludge three times a year. The manner of removal is to put the tank to be cleaned out of operation and run all the sewage through the remaining tank during the period of cleaning. At a level 3 ft. above the lowest point of the inclined bottom of the tanks is a 6-in. pipe which is connected with the sewage-receiving well at the pumping station. By opening a valve the volume of water between the bottom layer of sludge and the top scum is removed to the sewage well at the station, and the sludge and top scum are brought together as close as possible without allowing much of the sludge or scum to escape to the receiving well.

Each tank is equipped with an elevator fitted with an endless link chain with Salem steel buckets and driven by a motor. Temporary wooden troughs erected at each cleaning are used to carry the sludge from the elevator discharge to the sludge bed. With this apparatus, 100,000 gal. of sludge can be removed from the tanks in from 24 to 30 hours.

The sludge bed is simply an earth embankment, surrounding about half an acre of marsh land. The sludge has been dumped on this area since 1903. The sludge deposit is now 5 ft. 6 in. deep over the whole area. Recent analysis shows that it is too valuable a material to be thrown away. It is rich in fertilizing properties, as may be seen from the accompanying analysis made by Prof. F. W. Woll, of the Agricultural Experiment Station, University of Wisconsin:

	Per cent.
Moisture	1.61
Organic matter	58.12
Total nitrogen	2.23
Phosphoric acid	0.67
Potash	1.76

At ordinary prices of fertilizer ingredients, the sludge in the condition in which it was analyzed, that is while quite dry, would be worth about $8 per ton.

New Disposal Works

When it was decided in 1898 to locate the disposal plant at the present site there were only two dwelling houses near this location. The land in this vicinity has been rapidly built upon and the plant is now in a well-populated residence district. Therefore, the city has decided to move the plant 8000 ft. farther out and build an entirely new plant along the same lines as the present plant, but large enough to handle the increased amount of sewage efficiently. Ground has been purchased, contracts let and work begun for the erection of the new plant.

One of the mistakes made in the purchase of the present site was that we didn't look far enough ahead and bought a piece of land which was entirely inadequate for the increasing needs of the city. In consequence, because of no room to enlarge our plant, we labored for years under crowded conditions.

For the new site 95 acres of land have been secured, giving us ample room for additions to the plant as they become necessary from time to time. In this way we have provided for the increasing demands for sewerage facilities of a growing city for years to come.

The new disposal plant will consist of an entirely new sewage pumping station located about 300 ft. from the present one. The intercepting sewer will be extended from the old receiving wells to the new wells which are a part of the new station.

A duplicate set of pumps and engines will be installed in the new station and the sewage will be forced through a 20-in. cast-iron pipe a distance of about 8000 ft., to the new purification plant.

The new plant will consist of a new septic tank with five compartments so arranged that the scum or the sludge may be emptied easily upon the adjacent low land on specially prepared sludge beds or upon the ground, where it may be dried out and then ploughed under. The capacity of the tanks will be 2,000,000 gal.

After passing through the tanks the sewage will be automatically distributed over percolating beds similar in design to the old beds, but of more substantial construction. The initial area of the beds will be about three acres.

The filtering material in the old beds will be used in the construction of the new. After passing through the filter beds the effluent will be returned to Lake Monona through a reinforced-concrete sewer, rectangular in cross section, which will pass within 100 ft. of the new station on its way to the lake. Contracts for the sewage-receiving wells, the pumping station, the septic tanks and the outfall sewer have been awarded and work has been started.

The total cost of the plant and new site will be in the neighborhood of $200,000, of which $20,000 is for the 95-acre site.

*An earlier plant, combining chemical precipitation and rapid filtration, was described in our issue of Dec. 28, 1899, at which time we pointed out some peculiar features of the construction contract. In our issue of Jan. 18, 1900, p. 40) we stated, with editorial comment, that the city had declared the contract not fulfilled, that the contractor had abandoned the plant and the city taken it in hand. On Oct. 11, 1900, we published an abstract of a detailed report on the plant by Prof. F. E. Turneaure, showing how the plant had failed to comply with the contract. On p. 177, of our issue of March 14, 1901, the abandonment of the old plant by the city, on advice of the city attorney, was noted, and on p. 182 of our issue of Mar. 6, 1902, we published a decision of a lower court, in which judge and jury declared the old plant forfeited to the city by the contractor, and the bondsmen liable for its $25,000 bond and $1045 interest charges. The plant which is the subject of the present article by Mr. Mackin was described in a paper by Prof. Turneaure in our issue of Oct. 17, 1901 (see also slight correction, p. 351, Nov. 7, 1901).

†Superintendent of Sewage-Disposal Plant, Madison, Wis.

A Wrapping-Protected Coating for steel pipe is made a new feature by the National Tube Co., of Pittsburg, Pa. Its merits appear to be (1) that damage of the coating by abrading or chipping is minimized, (2) that a thicker and stronger coating results, and (3) that by virtue hereof the pipe is in effect provided with electric insulation, so that the danger of electrolysis is produced. The coating is produced by first dipping the pipe in a hot bath of bituminous compound, and then wrapping on spirally a strip of fabric saturated with the compound. The turns of the fabric are lapped over each other about 1 in. Several thicknesses may be applied for special cases. Joints and special points must be wrapped in the field, for which fabric and compound are furnished. One-ply coating is said to be about $\frac{3}{64}$-in. thick, several times the thickness of ordinary paint or dip coating. The new protection is called "National Coating" as a trade name. A circular of the company says "it can now be applied to pipe ranging in size from 3 to 18½ in. outside diameter," but other sizes will be handled later.

Irrigation Management

By F. W. Hanna*

The author deals chiefly with the operation, rather than the maintenance or general upkeep, of large irrigation systems. The organization of the maintenance force, the continuous-flow and rotation method of distributing or giving out the water to individual consumers, and the important subject of water measurement are first discussed. Brief mention is made of a self-registering meter devised by the author and tested on the Boise Project of the U. S. Reclamation Service. Record keeping is considered. In conclusion, stress is laid on the importance to the irrigation engineer of the knowledge of human nature and also of the principles of scientific agriculture.

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The degree of financial success of an irrigation system depends on the efficiency of its management as well as on its excellency of design and construction. An improperly designed or constructed, and likewise an improperly managed, irrigation system may make a financial failure of the irrigation project. The irrigation engineer in charge of an irrigation system must, therefore, not only design and construct it in a practical, efficient manner, but he must also manage it in a manner to insure the proper investment income.

The management of an irrigation system may properly be divided into maintenance and operation. Of the maintenance of the system, little need here be said except that it is on the side of wisdom and economy to keep all of the structures and canals of the system in excellent condition at all times, as they are the machinery of water distribution and must, therefore, be in good repair to give efficient and constant service. If an irrigation system has been properly designed and constructed, this feature of irrigation management is not a complicated one, as it only requires constant vigilance, judgment and action with a view to keeping the parts of the system in serviceable order for the functions for which they were designed and constructed. How to operate a canal system, however, so that each irrigator shall receive his water in the quantity and at the rate and time required by his crops is a difficult and perplexing problem, inasmuch as it primarily involves knowledge of the complicated questions of water distribution and of water application with all of their ramifying business details.

The organization for effecting the distribution of irrigation water by large companies necessarily consists of a field force, an office force and an administrative officer coördinating and directing these two forces, and the size of these forces depends mainly on the method of water delivery. The field force is principally comprised of ditch riders and water masters. Each ditch rider patrols and cares for 10 to 20 miles of ditches, measuring out the water to the users individually or in groups, and reports his deliveries and water needs by mail or telephone to his water master. Each water master supervises 10 to 20 ditch riders and furnishes them with their daily delivery schedules, adjusts complaints, so far as possible, in his division and reports to the administrative officer. The office force works out the program of deliveries for the water masters, compiles the final records of deliveries, collects and disburses money and handles the office correspondence. The administrative officer fixes the policies, adjusts unsettled complaints, either personally with the water users, or through the water masters, and directs the work in all of its broad phases.

There are two methods of water distribution, the continuous-flow method, and the rotation method. In the continuous-flow method, the water user receives his water in a continuous stream, and in the rotation method he receives it at frequent predetermined intervals. Each of these methods has its advantages and disadvantages.

The continuous-flow method is adapted to use on large land holdings; it gives the irrigator full control of all his water all the time; and it is conducive to a low operation cost. On the other hand, this method of water distribution has the disadvantage of requiring continuous care to prevent wasteful use of water resulting in over-irrigation, low water duty and drainage needs.

The rotation method is adapted to use on small land holdings, where it is necessary to obtain additional water to get a good irrigation head. It gives relief from constant care of the water throughout the irrigation season, is conducive to economy in the use of water, promotes soil cultivation and results in healthy soil conditions. In the rotation method, the rotation is practiced between individual users on a sublateral or between groups of individual users by sublaterals or between groups of individual users by laterals. In a large irrigation system, therefore, the continuous-flow method and the rotation method are combined, the continuous-flow delivery terminating with the canal, lateral, or sublateral, as the case may be.

Canal organizations in the earlier irrigation days operated and maintained only the main canals of their systems, turning out the water into the laterals and requiring the users to operate and maintain them. This plan required only a small operating force and, while largely practiced at present, is gradually falling into disfavor among the more progressive water users and canal companies. The water is now being delivered to the users in many cases, and larger operating forces are employed, resulting in higher operation and maintenance costs. It has been found that water users are slow to organize, neglectful of maintenance, careless and often unjust in water distribution. The nature of the farming occupation is not conducive to coöperation. The farmer needs his full time for farming operations and finds it burdensome to care for the delivery of water to his farm. There has been, and will continue to be, a strong tendency toward the division of labor here as in commercial and manufacturing industries, and the natural point of such division, from the view points of efficiency, justice, harmony and economy, is at the farm headgate.

The problem of the greatest difficulty and importance in the management of irrigation systems is the accurate and equitable measurement of the water. In the earlier days of canal companies, this problem was not so important, as there was usually an abundant supply of water, and consequently much of it was delivered without measurement. When the water was measured, the unit and method of measurement in use by the Western miners were generally adopted. The unit of measurement, after having been made definite by statutes, has proven only fairly satisfactory, and the miner's inch is gradually being displaced by the second-foot as a more satisfactory, uniform and tangible unit.

The method of measuring the miner's inch consisted of passing the water through an orifice 1 in. square with a specified depth of water over the top of the orifice. Greater quantities were to be obtained by increasing the orifice length. Such a measuring device is not suited to the measurement of large quantities of water, and is subject to trouble from débris-laden water. In order to obviate these difficulties, the old devices for measuring the miner's inch have necessarily, to a great extent, given place to submerged orifices with unrestricted dimensions and pressures, and to rating flumes and weirs. The submerged orifice gives good service where there is little

fall available for effecting measurement and the water is free from débris.

Rating flumes are particularly serviceable where there is an unusual quantity of silt in the water and where necessary fall for weir measurements is lacking; but, where only normal quantities of silt exist and there is sufficient fall, it is difficult to devise a more satisfactory means for irrigation-water measurement than the weir when properly installed. The weir formulas are not accurate, however, for depths over the weir crests in excess of one-third their lengths, and this fact is being ignored by many canal companies, resulting in the delivery of too much water to the users. Experiments on the Boise project, conducted under the writer's direction, show, both for the Cippoletti and the standard weir, increasing excess discharges over those obtained from the formulas as the depth increases from one-third to full crest length, reaching 9 to 17% at this higher limit. Discharges for depths over weirs greater than one-third the crest lengths should, therefore, either be avoided or be taken from carefully prepared tables. Where there is insufficient fall for the use of free weirs, submerged weirs are sometimes used, but they are not at all popular with the water users, on account of their rare use and complicated formula. The submerged weir gives fair results, however, when treated as a free weir and the depth of submergence does not exceed 0.1 or 0.2 of the up-stream head on the weir. In obtaining measurements by means of any of the measuring devices described, readings taken once or twice a day furnish a basis for estimates of the actual discharges on certain assumptions as to the flow of water between the readings. These readings generally are reduced to miner's inches or second-feet by means of tables, although, in some cases, scales reading directly in miner's inches or second-feet are installed at the measuring devices. Several water registers or gages have been devised that record the fluctuations of the water surface at the measuring device. From the records of these machines, the means of the indicated heads are ascertained, and the discharges are computed in acre-feet, but this is a tedious process of obtaining the desired data and gives only approximate results. Engineers have, therefore, for some time been interested in devising an instrument that will automatically record accumulatively the amount of water discharged by canals and laterals, regardless of fluctuations of water surface in them; and there have been some instruments invented that have this object for their purpose.

During the past year the writer has had tested, on the Boise Project, a patented invention of his own of the self-registering water-meter type that promises to give satisfactory results. This instrument consists, essentially, of a float, a clock and a mechanical integrator registering the discharge in acre-feet, and is applicable with facility to weirs, submerged orifices, rating flumes and open channels. Successful instruments of this character will have a beneficial effect in establishing an economical use of water by furnishing a means of handling water as a measured commodity.

The keeping of records of the quantity of water delivered to the users is an important question in the handling of a large irrigation system. By keeping and studying the records of inflow and outflow in the canals and laterals, heavy and unusual losses can be detected, the causes ascertained and the conditions corrected in many cases; the patrolmen can be charged with the water received by them and again credited with the quantity delivered, thereby resulting in honest, careful and accurate distribution of the water. From the standpoint of dealing with the water users and understanding their needs, carefully kept records are very valuable, as there is always considerable complaint among water users as to irregularity in flow and shortage in quantity of water received. Well kept records are always the best answers to such criticisms, when unjust, and furnish a ready means of discovering any injustice that may be obtaining. The duty of water naturally varies with the season, and a different duty of water is, therefore, required for each month in the irrigation season; and it is important to know what duty of water to consider applicable to the lands of the system, particularly where extensions are contemplated, and additional appropriations from the water supply are likely to prevail. Records of deliveries properly compiled by months will indicate what this duty should be, and will also give desirable information as to the annual duty. State laws usually require beneficial use of water in order to establish a right to its use, and, as irrigation development progresses, canal companies will be called upon to show beneficial use of their diversions of water, which can be demonstrated only by a carefully kept record of water deliveries for years. The records should consist of the original daily entries made by the patrolmen in miner's inches or in second-feet, supplemented by compilations by the office force, showing the monthly quantities in acre-feet received into and delivered out of each canal and lateral and those delivered to each water user. Such records, with crop statistics, provide a source of most valuable information.

Like many other large industries, the management of an irrigation system of size involves personal dealing with a large body of men and requires abundance of tact and knowledge of human nature. Human nature must be understood, not for the purpose of circumventing the desires and interests of the water users, however, but for the purpose of ascertaining and promoting those desires and interests and harmonizing them with the rights of others. The interests of one water user may conflict with those of one or more other users or with those of the canal company, and his desires may even conflict with his own interests. Out of these conditions the irrigation engineer must select the reasonable and just course of action; and in doing this he must act on the principles, that all men are created equal and are entitled to a square deal. In order to act justly in these matters, the irrigation engineer should, by all means, understand the broad principles of agriculture. While it has already been suggested that the division of labor in the process of irrigation should be between distribution and application of water, yet it is considered that the distributor can not perform his function intelligently without a good knowledge of the use of water in crop production. The irrigation engineer should be informed on the merits of the various methods of irrigation and their adaptability to different soils and crops; he should know the sources of water loss on the farm and how to reduce this loss to a minimum; he should be familiar with the crops grown and their water requirements; and he should be conversant with the problems of soil fertility, alkali and drainage. Agriculture is, of necessity, rapidly becoming a science, and in the course of a few decades will be practiced by scientific men. In the transition from the present semi-scientific methods to future scientific agriculture, there is going to be a great opportunity for those in positions of vantage to assist in making this transition a rapid, economical one for an individual or for a community, and especially is this true of the irrigation engineer in charge of water distribution on a large irrigation project.

Employees' Suggestions have been found of great value by the Pennsylvania R.R., according to a bulletin which announces the first results of a plan inaugurated a short time ago. The response to the company's offer to pay for money-saving suggestions was immediate. Among the ideas for which money was paid were one submitted by a roundhouse clerk for increasing economy by the further use of carbon sheets left in repair-card books, a tinsmith's scheme for an improved method of fastening flag and torpedo boxes in engine cabs, a fireman's suggestion for reducing the loss of coal from tenders by standardizing the height of coal gates, and an improvement made by a car inspector in an appliance used for cleaning and sterilizing drinking cups.

Although a great many worthless suggestions came in, officials of the railroad state that the saving effected by those which have been adopted have made it worth while to investigate all those received. Aside from these direct benefits, there is believed to be an indirect gain in the added interest taken by the employees in their work.

A New Type of Retaining Wall

In track-elevation work through built-up city districts, where the new grade is to be on a solid fill between retaining walls, the design and construction of these walls is sometimes affected materially by right-of-way conditions. Thus in some cases buildings erected close against the property line of the railway may complicate matters as to the foundations of the walls, and also as to the erection of forms if these walls are to be of concrete. These conditions were mentioned by Mr. J. H. Prior, assistant engineer of the Chicago, Milwaukee & St. Paul Ry., in our issue of Apr. 20, 1911, in connection with some special designs of reinforced-concrete retaining walls which had been prepared to meet these conditions. The designs in question applied more particularly to

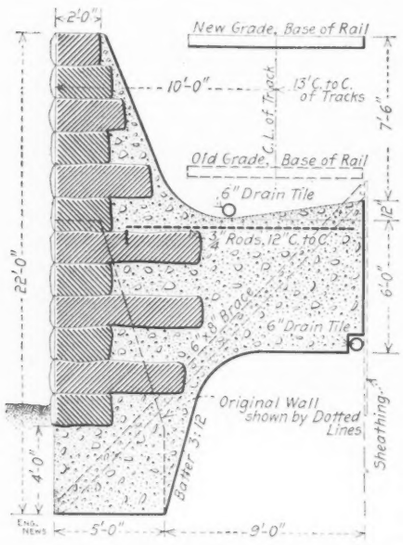

FIG. 1. RETAINING WALL OF HAMMER-HEAD SECTION; CHICAGO & NORTHWESTERN RY.

keeping the footings and foundations within the property line, while at the same time enabling the railway company to make use of its own property up to that line, thus avoiding any waste of space in a location where every available foot of ground is needed.

Similar conditions have been met in some of the track elevation work on the Chicago & Northwestern Ry. in Chicago. In at least one case, the existence of buildings occupying adjacent property right up to the railway company's property line made it practically impossible to build a concrete wall without involving waste of ground, since all form work would have to be inside the limit of the company's property. In this case, therefore, the face of the wall was built of stone, serving as a permanent form for the mass of concrete to which it was closely bonded. The place in question was between May and Wade Sts., on the Wisconsin Division approach to the new terminal station. The tracks were originally elevated in 1898-99, and the intersecting streets were depressed so as to give a headway of 12½ ft. With the construction of the new terminal, these tracks had to be further elevated so as to give at street crossings a clear headway of 14 ft. without any depression of the street. The masonry wall of the earlier track elevation work could not be utilized in the new work.

The conditions here presented resulted in the design of a wall of a new type of section, being in the form of a T laid sideways, and termed a "hammer-head" section. This is shown in Fig. 1. For drawings of this retaining wall we are indebted to Mr. W. C. Armstrong, engineer of bridges, Chicago & Northwestern Ry. (who was terminal engineer in charge of the construction work on the new terminal). Fig. 2 is a view showing the construction in progress, with the wall completed nearly to the top of its horizontal portion or heel. In the background may be seen some of the reinforcing rods in place. To reduce the interference with the tracks to a minimum, the excavation was made only just wide enough for the wall, and the vertical face of the old filling was supported by sheeting with waling timbers braced by inclined timbers which were left embedded in the concrete, as shown in Figs. 1 and 2.

The following details regarding the design and construction of this type of wall are abstracted from a paper by Mr. Armstrong on "The New Passenger Terminal of the Chicago & Northwestern Ry.," which is published in the December number of the *Journal* of the Western Society of Engineers (Chicago).

The old retaining walls were built of rubble limestone on a natural-cement concrete base. The face of the wall was vertical and on the right-of-way line, outside of which was private property. There was no projection of the concrete footing beyond the face of the wall. The base was too narrow to permit of raising the wall higher by additional masonry, and the natural-cement concrete had disintegrated so badly in places as to be unfit for sustaining a greater pressure.

To have excavated for a new base of a standard wall, of the proper width for the increased height, would have necessitated either the temporary removal of two tracks or the use of very heavy shoring to hold back the embankment. The former was objectionable, for the traffic was heavy at this point and it was desired to avoid increasing the congestion as much as possible. The latter was also objectionable on account of the cost that the work would involve and the danger that would attend any scheme for shoring in such a restricted space, for shores could not be placed outside the right-of-way line.

It was impracticable to rebuild the wall entirely of concrete unless the face was set back from the right-of-way line a distance equal to the thickness of the forms; for in many places houses were built snug up against the face of the old wall. To meet these conditions a special type of wall was designed and constructed (as shown). One track was temporarily removed and the sand filling excavated. The old wall was then removed entirely. The concrete footing under the toe of the wall was then put in place.

The face of the new wall was built of dolomite limestone from the Duck Creek quarries in Wisconsin. This is of very good quality for heavy masonry if protected from the percolation of water. But, like all limestones, it will disinte-

FIG. 2. RETAINING WALL UNDER CONSTRUCTION (BETWEEN CARPENTER ST. AND MAY ST., LOOKING EAST.)

(The braces for the sheeting are left in place, embedded in the wall.)

grate more or less when used in damp places and subjected to freezing and thawing. The face of the wall was laid with alternate headers and stretchers, while the backing was of concrete. No headers were allowed to be used with tapering points, and if a header was wider at one end than at the other, the narrow end was made the face. In that way the header was dovetailed into the concrete backing.

The heel of the wall was at a considerable distance above the toe, and from the peculiar shape given to the rear portion, the term "hammer handle" is a nickname that has been applied to this construction. The thickness of the tail was usually made about 5 ft. at the shallowest point, which was about 5 ft. from the rear end. The upper surface of the tail was given a concave finish to facilitate drainage. A 6-in. tile drain was laid in

the trough thus formed, and this carries the water to manholes (at the street lines) connected with the city sewers. Under the heel of the wall are placed 6-in. drains which connect with the same manholes.

In order to bind the tail more firmly to the body of the wall, and to prevent rupture through the tail, due to the downward pressure upon it and the outward pressure on the upper part of the wall, ¾-in. reinforcing bars spaced 12 in. apart were placed horizontally within about 6 in. of the upper face of the tail. These bars were bent down at one end and anchored into stone headers.

Careful records have been kept since the completion of these walls and the resumption of traffic on the tracks over them, but no movement of any kind has been detected. Some of them have now been in use about 10 months.

Mr. Armstrong suggests that there is one feature of this type of wall that might frequently be employed as a measure of economy. That is the saving in excavation and masonry effected by setting the foundation of the heel higher than the foundation of the toe. There are usually but two reasons for carrying the foundations of a retaining wall lower than the surface of the ground: (1) to reach a material that will sustain a greater pressure, and (2) to get the foundation below the action of frost. The first is usually only necessary under the toe of the wall, for almost any good soil will sustain the heel pressure. The second also is only necessary under the toe, for the heel is protected from frost by the embankment.

The Drainage of River Bottom Lands by Pumping*

By John J. Harman†

Of the 70,000,000 acres of swamp and overflowed lands in the United States about 20,000,000 acres lie in the Mississippi River valley, and a large percentage of this area is so situated, topographically, that it cannot be successfully drained except by pumping.

During recent years a large number of drainage districts have been organized in the Mississippi River valley, in which pumping is required.

In designing pumping plants for this work, the first matter to be considered is the type of prime mover and pump which should be used. The conditions which govern their selection vary considerably in different localities, chiefly on account of the difference in head and the relative accessibility of the plants. In some places these plants have to be installed at points which are so difficult of access that the cost of delivering fuel is greater than the purchase price, and in such cases the demand for high fuel economy is greater.

Another factor of great importance in the selection of the type of machinery is the availability of operatives capable of handling the machinery, who will be willing to live at an isolated plant. In most cases, except where the pumping plant is in an easily accessible location, it has been found advisable to employ a man with a family and to provide him with a comfortable home at the site.

Internal combustion engines, electric motors and steam engines have all been used to some extent in this class of work. The internal combustion type of prime mover (including producer-gas and oil engines) has some strong arguments in its favor, but the availability of proper operatives must be given careful consideration. Electric motors fit in very nicely for small plants located near an available supply of electric current, and the convenience of operation will often offset the increased cost of power, even in plants of considerable size. Properly designed steam plants have a very good fuel economy, together with considerable overload capacity, and can be readily operated at the various speeds necessary to the economical operation of the pumps under different heads.

Several types of pumps have been used for this class of work, including the propeller lift pump, the paddle or scoop wheel, and the low-head centrifugal pump. Rotary and piston pumps have been tried, but these are subject to rapid deterioration from the cutting action of the gritty water which they are required to handle. The propeller lift pump and the paddle wheel pump, as installed in this country, will have to be constructed in a more permanent manner, so that they can be properly maintained if they are to hold their position in this kind of service. Scoop wheels of a permanent type of construction have been used quite extensively in England and Holland. These plants operate quite economically at low pumping heads, but are expensive to install properly for the extreme ranges of head encountered in the upper Mississippi River valley.

Taking all these things into consideration, the types of prime mover and pump which at the present time appear to be best adapted to our average conditions, are the steam engine and the low-head centrifugal pump.

Experience shows that the average drainage commissioner has a tendency to economize in the maintenance of a plant to such an extent as to endanger its operation at the time when water conditions are the worst, and the demand on the plant is at a maximum. This false economy has, in many cases, resulted in immense damage to the crops within the district, and has shaken the confidence of investors in projects of this character. Great saving can be made by always operating the plant at its most economical point.

Lack of authentic information regarding the capacity and efficiency of low-head centrifugal pumps at various heads and speeds seriously complicates the problem of determining the most economical operating conditions. Even when correct information regarding the pump is available, the friction of suction and discharge piping is usually such a large percentage of the total head that each plant becomes more or less a problem of its own, and should be studied individually.

Our own experience indicates that the proper method of determining the most economical pump speeds and steam pressures for the various operating conditions is by making a series of tests on the pumps, engines and boilers, with various speeds and steam pressures at the different heads encountered in practice. From these data an operating chart can be made, showing the proper operating conditions for the different heads.

The following example illustrates very forcibly the extent of the loss, due to inefficient operation, which may occur when the plant is operated without regard for the proper operating speeds for the different pumping heads. Recent tests made on a 45-in. low-head centrifugal pump, operating against a total head of approximately 3.5 ft., showed a pump efficiency of 40% at 110 r.p.m., and 26% at 135 r.p.m. The plant had been operating at 135 r.p.m. and was delivering to the pump almost twice as much power (per million gallons pumped) as would have been required at 110 r.p.m. In determining the most economical speed, however, the efficiency of the engine must also be taken into account, as the amount of water delivered by the pump falls rapidly at the decreased speed, and the consequent reduced load on the engine is attended with loss due to the increased cylinder condensation, throttling, etc.

It is practically impossible to employ and keep at the plant the quality of talent necessary for the most economical operation at all times. The experience of many drainage districts indicates that it would be highly profitable to the land owners, as well as affording them greater security against breakdowns at the plant, to place the operation of the pumping plant in the hands of a competent drainage engineer who would make tests from time to time, purchase the necessary fuel and supplies for the plant, keep the accounts and pay the bills, as well as supervise the operation of the plant and look after its proper maintenance.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, held at the University of Illinois (Urbana, Ill.), Jan. 17-19.

See Bulletin No. 243, "Land Drainage by Means of Pumps"; Drainage Investigation Division of the Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C.

†Harman Engineering Co., 120 Fredonia Ave., Peoria, Ill.

Special Venturi Meters at the Wachusett Dam

By E. R. B. Allardice* and F. N. Connet†

When the Wachusett Dam of the Metropolitan Water Works,, of Massachusetts, was constructed, a substantial granite building was erected at its base to serve as a hydro-electric power station. It was estimated that about 3000 hp. could be developed at a nominal cost by the fall of water before it entered the aqueduct leading to Boston.

The generating machinery, which was not installed upon the completion of the dam owing to press of business on more important construction and to legal and other difficulties, has been recently erected. There are four 1200-hp. horizontal turbine wheels of the volute-casing type, built by the S. Morgan Smith Co., of York, Penn. Each turbine is directly coupled to a 1000-kw. Westinghouse alternating-current generator for three-phase, 60-cycle current at 13,800 volts. The current is supplied to the Connecticut River Transmission Co., which in turn supplies the Lancaster Mills in Clinton, about one mile below the dam.

The water from the Wachusett reservoir passes through the dam via four vertical brick-lined wells 84 in. in diameter by 111 ft. high, thence through four 48-in. horizontal cast-iron pipes about 130 ft. long, which are entirely embedded in the masonry of the dam. These pipes terminate under the foundations of the power house, and from them connections are made directly upward to the turbines which are set upon the main floor of the building, as shown in Fig. 1. After passing through the turbines the water is conducted through concrete channels directly into the Wachusett Aqueduct, leading to Boston.

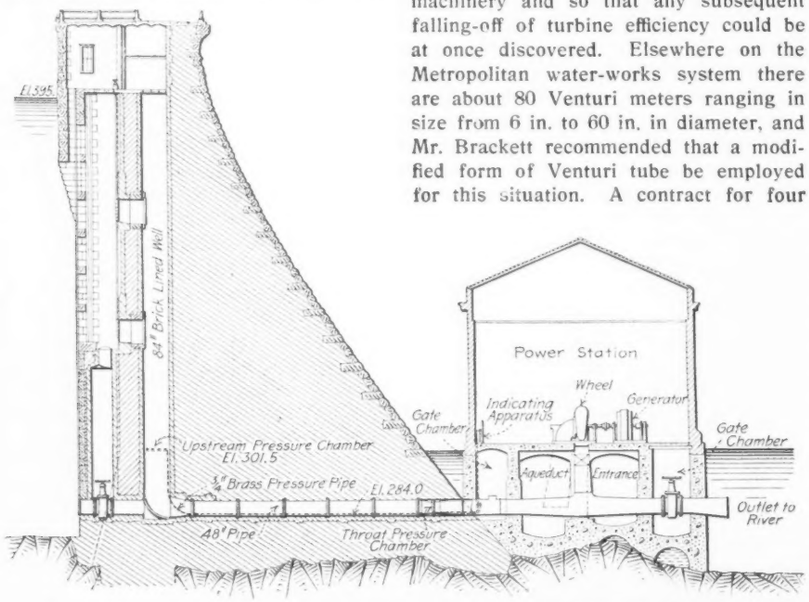

Fig. 1. Sectional Elevation, Showing Location of Venturi Meters at Wachusett Dam Power Station

Chief Engineer Dexter Brackett, of the Metropolitan Water and Sewerage Board, desired to accurately measure the total amount of water delivered to the aqueduct and also the individual amounts supplied to each turbine, so that accurate data would be available during the official acceptance tests of the generating machinery and so that any subsequent falling-off of turbine efficiency could be at once discovered. Elsewhere on the Metropolitan water-works system there are about 80 Venturi meters ranging in size from 6 in. to 60 in. in diameter, and Mr. Brackett recommended that a modified form of Venturi tube be employed for this situation. A contract for four special meters was awarded the Builders Iron Foundry, of Providence, R. I.

Owing to the impracticability of placing upstream pressure-chambers in the 48-in. pipes on account of the high velocity of the water, which was to be about 14 ft. per sec., it was decided to remove several courses of brick from the lining of the 84-in. wells and insert a special form of pressure-chamber having numerous vent holes flush with the inner contour of the wells. The position of these chambers is shown in Fig. 1. These would serve in place of the upstream pressure-chambers of ordinary Venturi tubes.

Special throat-castings 40 in. in diameter were firmly attached to the interior of the horizontal 48-in. pipes at points about 90 ft. distant from the upstream chambers. These castings have annular pressure-chambers and are lined with bronze accurately bored to the standard Venturi curves.

Brass pipes, attached to the interior surfaces of the wells and of the 48-in. pipes, connect with the eight pressure-chambers and transmit the pressures to four special instruments set on the main floor of the power house. These instruments are shown in Fig. 2. They have three dials, one for indicating the rate of flow in gallons per day, one for continuously recording this rate upon circular chart paper, and one for registering the total quantity in gallons. These instruments are so sensitive that they respond instantly to the slightest change in the gate opening of the turbines. The chart records show exactly when each generating unit is started and stopped, and the rate at which it has operated. Fig. 3 gives a closer view of one of the

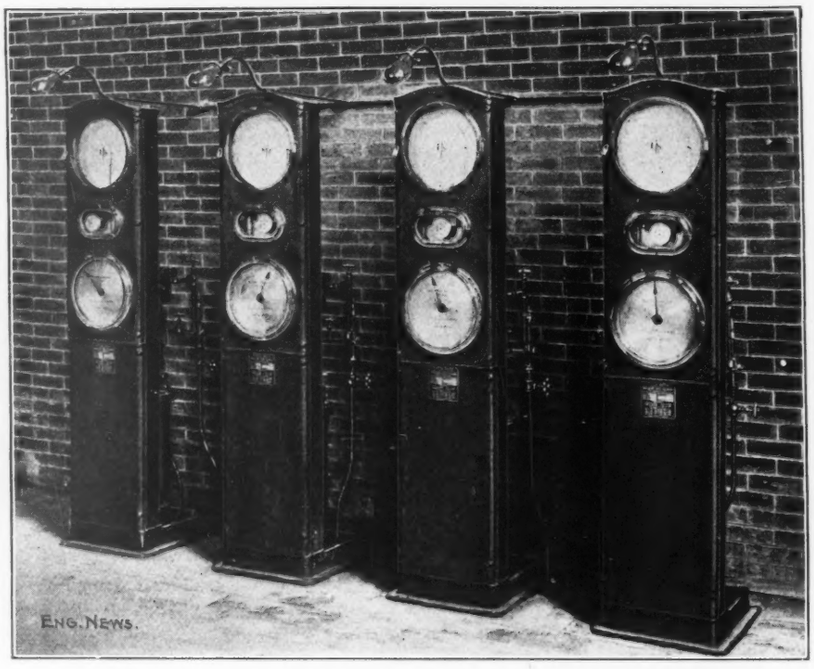

Fig. 2. Recording Instruments for Wachusett Dam Venturi Meters

*Superintendent, Wachusett Dept., Metropolitan Water-Works, Clinton, Mass.

†Builders Iron Foundry, Providence, R. I.

instruments with a chart record three-fourths completed.

This method of measuring the water dispenses with all mechanism in the path of the flowing water as the readings of the instruments depend solely upon the relative pressures in the two small pipes leading to the pressure-chambers. The Venturi meter is based upon the relation between velocity and pressure in water flowing through a continuous pipe of varying cross-sectional area. In flowing through the tapering Venturi tube from the full section to the smaller throat, the water gains velocity at the expense of pressure, since the same volume of water per unit time passes each section. The pressure at the throat is thus less than that at the upstream entrance, and the amount of water passing through the tube has been found by experiment to be very nearly equal to the theoretical discharge through an opening of the same size as the throat at a velocity equal to that which would be caused by the difference in pressure at the throat entrance. By means of relatively small tubes leading respectively from the upstream end and the throat of the Venturi tube, the pressures at these points can be taken, and an indicating needle can be made to mark the difference between these pressures. By means of charts suitably calibrated, readings for rate of flow can be obtained directly in cubic feet per second or other units.

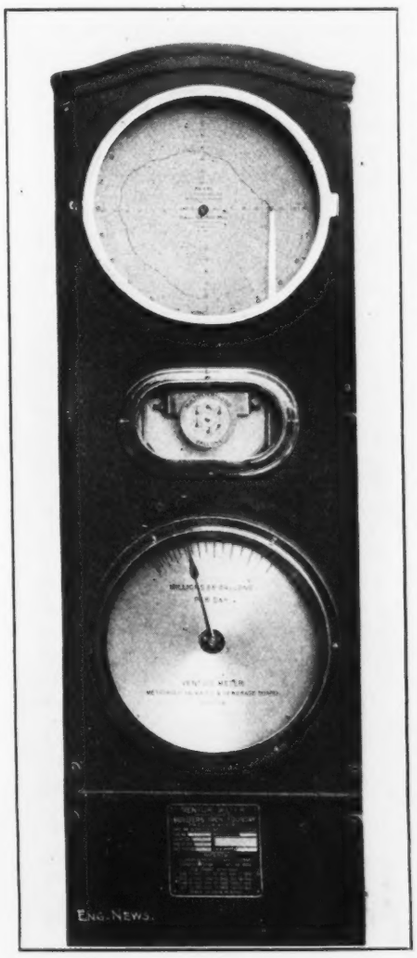

FIG. 3. INDICATING, RECORDING AND REGISTERING INSTRUMENT FOR SPECIAL VENTURI METER AT THE WACHUSETT DAM

(Photo taken at 6 a.m. Record chart stands with midnight radius at top and noon below.)

As the conditions under which these meters were to operate were so abnormal, it was decided to subject them to a rigid calibration after installation. This was accomplished by the engineering force of the Metropolitan Water Works by means of current meters at the rating station in the Wachusett Aqueduct about 2½ miles below the power station. The discrepancies found were very slight, and after the Venturi instruments were permanently graduated to correspond with the current meters, the latter were removed from the aqueduct and henceforth the Venturi meters will be considered as standard.

Emerald Mining and Extraction in Colombia*

BY CHARLES OLDEN†

The emerald deposits in the Republic of Colombia are the only known deposits of emeralds in South America.

The Spaniards first knew definitely that emeralds were to be had in Colombia on Mar. 3, 1537, when the Boyacá Lndians gave them presents of this gem as peace offerings. The deposits were worked at intervals by the Spaniards down to the Declaration of Independence of the Republic, when they became the property of the government. Since 1844 the mines have been worked under lease from the government. Two years ago the mines were leased for a period of 20 years to an English company working in partnership with the government.

Situated on a spur of the eastern Cordillera of the Andes, the Muzo emerald deposits lie in a natural valley somewhat resembling a funnel in shape, at altitudes ranging from 3000 ft. to 4000 ft. above sea-level.

The Muzo emeralds occur in calcite veins traversing black carboniferous limestone, in which are found ammonites and other fossil remains, which fix the age of the deposit as Lower Cretaceous. The gems are found in pockets in the calcite or as separate crystals. They are found also embedded in the formation, with or without an envelope of calcite matrix.

Usually the crystals are very much broken, as they are laid bare, and are recovered in fragments.

The deposits range in thickness from a few feet only, up to 300 ft. Large veins are not considered favorable to the production of good stones.

Having stripped the overburden for as large an area as is thought necessary, say, 150 ft. by 50 ft., where it is intended to continue the work on a productive bank, some preliminary examination of the newly-cleaned outcrop is undertaken.

There is always a great amount of dead work to be done before the emerald-bearing veins are uncovered, and the usual procedure is to cut into the formation, step-wise, benches or terraces, one row succeeding another as soon as the course is clear. The benches are 30 in. deep, and the full complement of men on a bank may reach as many as 150 or more.

Some idea may be formed of the immense amount of dead work which may be required to be done when the bank happens to be from 50 ft. to over 100 ft. high. Every ton of hard formation has to be broken down by manual labor, while at the same time the greatest care is needed to see that no gems inclosed in the matrix are thrown away with the waste.

Situated as high as possible above any new work which may have to be undertaken, there have been built three large tanks, or reservoirs, of masonry, which collect and store surface water conducted to them by ditches. From these tanks conduits are provided which lead to the foot of any bank upon which work is being done. From the foot of the banks the conduits are carried on until a convenient outlet is found into which the contents may be carried.

When a heap of waste rock has accumulated to inconvenient proportions at the foot of the bank, the tanks are emptied into the conduits and the accumulated waste is swept away.

The flushing method of getting rid of the waste has the very serious drawback of the possible washing away of pieces of formation containing calcite veins with embedded emeralds, or emeralds attached to the formation, which are more difficult to detect. Every care is exercised by the overseers on the banks to see that no matrix is thrown away which is likely to contain gems; but accidents may, and do, occur, causing losses, which will continue so long as the flushing method is in vogue.

A bank may prove absolutely valueless after months of work upon it. Despite the greatest care in the selection of the locality for starting the work, no one can estimate the probable value of any particular section of a deposit. In this respect emerald mining differs from most of the other branches of the industry. The lack of conformity exhibited by the calcite veins as to dip, strike or continuity in any one direction, deprive the engineer of all ordinary data upon which he could depend in forming a judgment,

*Brief abstract of a paper read before the Institution of Mining and Metallurgy, Dec. 21, 1911.

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and the usual element of chance is much increased.

The tools used are steel bars about 5 ft. long and weighing 30 lb., and shovels. The bars are forged to a point at one end and made wedge-shaped at the other. In the hands of an experienced Indian the bar proves very efficient in breaking down the formation. It has been estimated that each skilled miner can break down, in a 10 hours' shift, 93.75 cu.ft. of hard formation, using the bar alone. Explosives are used when necessary, and holes are "jumped" with the same tool, and charged with blasting powder made on the spot.

As the bank deepens and approaches the calcite veins, great care is exercised to prevent undue force being used in wielding the bar, owing to the risk of breaking the emeralds which may be in the immediate vicinity.

Upon arrival at the sorting sheds of the establishment, the valuable matrix is dealt with as follows: The larger pieces are broken up by light hammers and the resulting product is again reduced in size. Each piece is examined very closely for gems or emerald colorations, and the waste sorted out. The final product is reserved and is again broken by light tools. The emeralds which have become loosened are picked out, and if clean are placed into stock, while those gems to which matrix still adheres are placed in a bath of cold dilute hydrochloric acid until they are cleaned.

In working a wet mine the procedure is much the same as with a dry mine, except that the work assumes the form of a trench wide enough to embrace the particular veins which are continuing productive. Greater care is necessary in dealing with the waste and in handling the valuable matrix, owing to the more restricted area of operation and to the greater facility which exists for the misappropriation of the gems.

The topography of the deposits, as seen today, with its evidences of alteration in contour and general features, lends truth to the legend that the mines have been worked for 1000 years or more. The very primitive methods of mining and quarrying in vogue are undoubtedly those handed down by the ancestors of the present-day Indian workers. There is no evidence whatever that the deposits are likely to become exhausted for the next few hundred years.

An Automatic Dam Crest

By G. F. Stickney*

It is highly desirable in certain emergencies that the elevation of the crest of a dam be automatically responsive to a sudden rise in water behind it. The following article describes such an automatic crest which has been devised by the author.

*Supervising engineer, New York State Barge Canal, Albany, N. Y.

In view of the recent failures of several dams on account of insufficient spillways, the writer has thought it possible that the readers of ENGINEERING NEWS might be interested in the description of an automatic crest for dams, which has been devised by him.

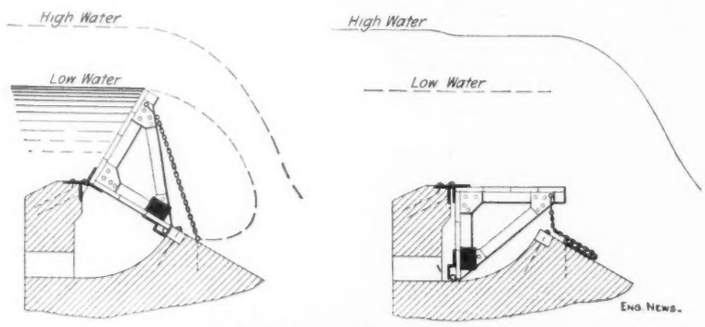
The automatic crest is a movable shutter placed on top of a dam, arranged to raise and lower with the variations of the water level. During normal conditions of flow the crest is elevated, increasing the height of the dam, and during periods of flood the crest is depressed, decreasing the height of the dam.

The water surface of a stream above a fixed dam fluctuates considerably at different seasons of the year, depending on the volume of flow. During the dry summer months when the flow is a minimum, the water is at its lowest level, which may be at the crest of dam or even lower, and during the wet months, when the flow is a maximum, the water passes over the dam several feet deep. Thus the height of the structure is limited by the necessity of keeping the high-water level down to a stage that will not overflow the banks or cause damage. High water occurs but a few times in a year and the flood periods are of comparatively short duration. A *movable* dam is an ideal structure for the water user, as it admits of raising the water surface to the highest permissible level, and can be lowered in time of flood, thus providing the maximum head and the greatest volume of storage, besides reducing the fluctuation of the water surface, all without increasing the flood height.

The automatic crest (Figs. 1-2) consists of two connected leaves placed at an angle to each other, preferably (though not necessarily) of 90°, joined horizontally at the axis of the hinge, by which the crest is attached to the fixed base of the dam. The leaves are held rigidly in their proper position, relative to each other, by ties, braces, etc.

The base of the dam contains a recess, into which the crest falls, the front of which is curved to conform to the path of the outer edge of the lower leaf, as the crest rotates about its axis, with just sufficient clearance for easy operation. A pipe or roller between the lower leaf and the base prevents excessive leakage of water at the joint, and chains, attached to the upper leaf and the base, or other suitable devices, are provided to limit the upward rotation of the crest. The water on the up-stream side of the dam has free access to the two leaves of the crest, to the upper face by the regular overflow and to the lower face through orifices provided for the purpose. In order that the crest may raise there must be a difference in the level of the water on the two sides of the dam, that is, there must be a distinct fall, and the tail water must not be above the axis of the hinges.

The water pressure against the upper leaf tends to rotate the crest downward and this force is supplemented by the weight of the crest and by a counterweight placed on the lower leaf. Opposed to these forces is the pressure of the water on the lower leaf, tending to rotate the crest upward.



FIGS. 1 AND 2. AUTOMATIC CREST FOR REGULATING THE FLOW OF WATER OVER DAMS
(Devised by G. F. Stickney.)

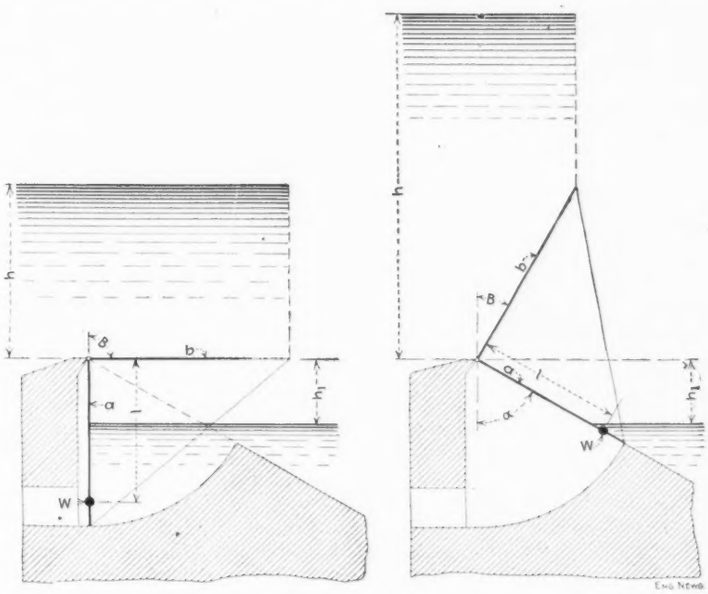
Fig. 1 shows the crest raised with water standing level with the top. This is the *low-water* level, the level below which the water will not fall unless the draft exceeds the natural flow of the stream. When the flow increases in volume, the surplus water spills over the top of the crest and runs to waste without lowering the dam. With a continuing increase in flow, the water surface gradually raises until the *high-water* level is reached at

which stage the crest falls, opening a way for the flood to escape. Fig. 2 shows the crest down at its lowest position, with a flood passing over the dam. As the flow diminishes, the water surface gradually drops until the *low-water* level is reached, whereupon the crest raises to its highest position as previously shown in Fig. 1.

The gain in head at a dam, due to the crest, is the distance between the *low-water* surface and the top of the masonry, as illustrated in Fig. 1.

Analysis of Operation

In the following analysis, one linear foot of dam is considered and the two leaves of the crest are assumed to be



Figs. 3 and 4

ing an angle, one with the other, of 90°. planes without thickness or weight, forming an angle, one with the other, of 90°.

When the crest is depressed the upper leaf lies horizontal and the lower leaf is vertical, as shown in Fig. 3. When the crest is elevated the upper leaf inclines at an angle of 30° and the lower leaf at an angle of 60°, with the vertical, as shown in Fig. 4.

The desired minimum depth of water over the base having been determined, the width of the upper leaf is fixed by the requirement of maintaining this minimum depth, when the crest is elevated. The width of the lower leaf is to be determined and it must be of such dimension that the water pressure will cause the crest to raise when the water surface falls to the minimum stage. The crest will fall, without the aid of a counterweight, when the overflow reaches a certain depth, but, to reduce this stage to a practical limit, the counterweight is necessary and the weight must be adjusted to the particular high-water stage selected.

Since the relative intensity of the water pressure on the two leaves varies as the depth changes, there is a critical stage, at each of the extreme positions of crest elevated and crest depressed, where the opposing forces are equal. After the crest commences to move the motive force increases as the rotation progresses, and hence it is not necessary to investigate any except the two extreme positions shown in Fig. 3 and Fig. 4, respectively.

The exact profile of the water passing over the dam is immaterial, as sufficiently accurate results may be obtained by assuming that the water surfaces are level and that the upper level terminates abruptly at the extreme end of the upper leaf. This supposition does not lead to a rigidly correct solution, but it simplifies the analysis and the error introduced is trifling.

The following notation will be used:

a = width of lower leaf in ft.;
b = width of upper leaf in ft.;
l = radius vector of counterweight in ft.;
α = angle between lower leaf and the vertical;
β = angle between upper leaf and the vertical;
h = depth of water over hinge in ft.;
h_1 = depth below hinge to top edge of recess or surface of backwater, whichever is highest, in ft.;
h_2 = depth of backwater over hinge in ft.;
P_1 = hydrostatic pressure against lower leaf in lb.;
P_2 = hydrostatic pressure against upper leaf in lb.;
W = counterweight in lb.;
M_1 = moment of pressure against lower leaf in ft.lb.;
M_2 = moment of pressure against upper leaf in ft.lb.;
M_w = Moment of counterweight in ft.lb.;
M = moment of all forces acting on the crest in ft.lb.;
w = weight of 1 cu.ft. of water = 62.5 lb.

The moments of forces tending to rotate the crest upward are positive, while those tending to rotate the crest downward are negative.

Case I.

Backwater not above the hinge as shown in Fig. 3 and Fig. 4.

The following formulas are general and apply to any position that the crest may assume:

$$P_1 = wa\,(h + h_1) - \frac{wh_1^2}{2\cos\alpha} \quad (1)$$

$$M_1 = \frac{wa^2}{2}(h + h_1) - \frac{wh_1^3}{6\cos^2\alpha} \quad (2)$$

$$P_2 = wb\left(h - \frac{b\cos\beta}{2}\right) \quad (3)$$

$$M_2 = \frac{wb^2}{2}\left(h - \frac{2b\cos\beta}{3}\right) \quad (4)$$

$$M_w = Wl\sin\alpha \quad (5)$$

$$M = M_1 - M_2 - M_w$$

or, substituting the values for M_1, M_2 and M_w, we have

$$M = \frac{wa^2}{2}(h + h_1) - \frac{wh_1^3}{6\cos^2\alpha} - \frac{wb^2}{2}\left(h - \frac{2b\cos\beta}{3}\right) - Wl\sin\alpha \quad (6)$$

When the crest is depressed, as in Fig. 3, $\alpha = 0$, $\beta = 90°$, and at the critical stage $M = 0$.

Substitute this value for M in equation (6) and reduce, noting that $\cos\beta = 0$ and $\sin\alpha = 0$, we have

$$\frac{wa^2}{2}(h + h_1) - \frac{wh_1^3}{6} - \frac{wb^2h}{2} = 0 \quad (6_I)$$

Solving for a, we have

$$a = \sqrt{\frac{3b^2h + h_1^3}{3(h + h_1)}} \quad (7)$$

Solving for h, we have

$$h = \frac{h_1^3 - 3a^2h_1}{3(a^2 - b^2)} \quad (8)$$

When the crest is elevated, as in Fig. 4, $\alpha = 60°$, $\beta = 30°$ and, at the critical stage, $M = 0$.

Substitute this value for M in equation (6) and reduce, gives

$$\frac{wa^2}{2}(h + h_1) - \frac{2wh_1^3}{3} - \frac{wb^2}{2}\left(h - \frac{2b\cos\beta}{3}\right) - Wl\sin\alpha = 0 \quad (6_{II})$$

Solving for $Wl\sin\alpha$, we have

$$Wl\sin\alpha = \frac{w}{6}\left[3h(a^2 - b^2) + 3a^2h_1 - 4h_1^3 + 2b^3\cos\beta\right] \quad (9)$$

Solving for h, we have

$$h = \frac{2Wl\sin\alpha}{w(a^2 - b^2)} + \frac{4h_1^3 - 3a^2h_1 - 2b^3\cos\beta}{3(a^2 - b^2)} \quad (10)$$

CASE II.

When there is backwater above the level of the hinge, as shown in Fig. 5 and Fig. 6.

The following formulas are general and apply to all positions of the crest:

$$P_1 = wa\,(h - h_2) \qquad (11)$$

$$M_1 = \frac{wa^2}{2}(h - h_2) \qquad (12)$$

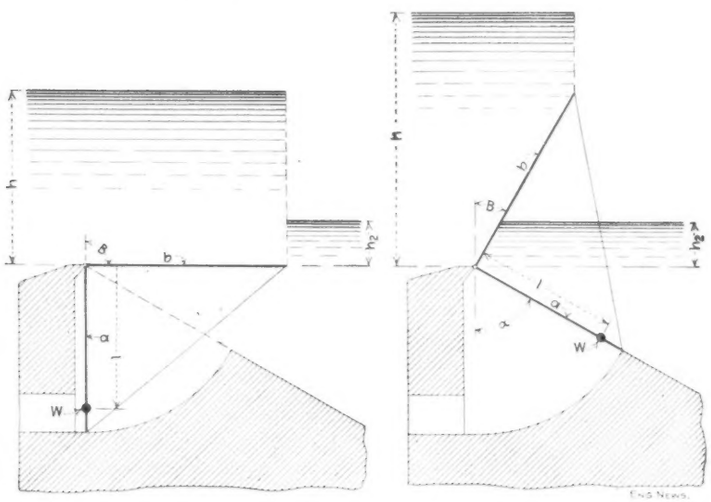
$$M_w = Wl\,sin\ \alpha \qquad (13)$$

The following formulas apply to the crest in all positions until the upper leaf dips below the backwater:

$$P_2 = wb\left(h - \frac{b\,cos\ \beta}{2}\right) - \frac{wh_2^2}{2\,cos\ \beta} \qquad (14)$$

$$M_2 = \frac{wb^2}{2}\left(h - \frac{2b\,cos\ \beta}{3}\right) - \frac{wh_2^3}{6\,cos^2\ \beta} \qquad (15)$$

$$M = M_1 - M_2 - M_w$$



FIGS. 5 AND 6

or

$$M = \frac{w}{2}\left[a^2(h - h_2) - b^2\left(h - \frac{2b\,cos\ \beta}{3}\right) + \frac{h_2^3}{3\,cos^2\ \beta}\right] - Wl\,sin\ \alpha \qquad (16)$$

The following formulas apply to the crest in all positions after the upper leaf dips below the backwater:

$$P_2 = wb\,(h - h_2) \qquad (17)$$

$$M_2 = \frac{wb^2}{2}(h - h_2) \qquad (18)$$

$$M = M_1 - M_2 - M_w$$

or

$$M = \frac{w}{2}(h - h_2)(a^2 - b^2) - Wl\,sin\ \alpha \qquad (19)$$

When the crest is depressed, as in Fig. 5, the leaves are submerged below the backwater and the pressure is of uniform intensity on both. As the upper leaf has the greater area, the lowering force is in excess of the raising force, hence it is evident that the crest will not rise.

When the crest is elevated as in Fig. 6, the backwater will cause it to fall at a somewhat lower stage of water than is the case when the backwater is below the level of the hinge.

This stage may be found by making $M = 0$ in equation (16) and solving for h, from which we have:

$$h = \frac{2Wl\,sin\ \alpha}{w(a^2 - b^2)} + \frac{3a^2h_2 - \frac{h_2^3}{cos^2\ \beta} - 2b^3\,cos\ \beta}{3(a^2 - b^2)} \qquad (20)$$

The following example shows the application of the formulas.

A movable crest is to be provided which will maintain the water surface at least 3 ft. above the fixed base of the dam and which will not fall until the overflow reaches a depth of 3 ft. above the crest. The backwater is 1 ft. below the hinge level.

Now the width of the upper leaf b necessary to maintain a depth of 3 ft. is

$$\frac{3}{Cos\ 30^\circ} = 3.46 \text{ ft.}$$

The width of the lower leaf a which will cause the crest to rise when the water is 3 ft. deep over the base is found by formula (7).

Here $h = 3$ ft., $h_1 = 1$ ft. and

$$a = \sqrt{\frac{3 \times 3.46^2 \times 3 + 1^3}{3(3 + 1)}} = 3.01 \text{ ft.}$$

The counterweight, necessary to lower the crest when the water reaches a depth of 6 ft. over the base, is found by formula (9).

Here $h = 6$ ft., $\alpha = 60^\circ$, $\beta = 30^\circ$ and

$$0.866\,Wl = \frac{62.5}{6}\left[3 \times 6\,(3.01^2 - 3.46^2) + 3 \times 3.01^2 \times 1 - 4 \times 1^3 + 2 \times 3.46^2 \times 0.866\right]$$

$$= 442.87 \text{ ft.-lb.}$$

$$Wl = 511.4 \text{ ft.-lb.}$$

Make $l = 2.5$ ft., then $W = 204.6$ lb.

The above analysis is intended to illustrate the principle of the device and has been simplified by disregarding the weight of the crest proper, which, of course, must be considered in practical designing. By properly proportioning the width of the leaves and the counterweight, the crest may be made to operate at any one of a variety of stages of overflow, and to limit the water surface fluctuation to one-half of what it would be with a fixed dam.

Weak Points in the Construction of Small Steel Highway Bridges*

BY NEAL B. GARVER†

It is well known that the grade of work done on small steel highway bridges is far below that done on railway bridges. The only explanation to be offered for this condition is that the methods of letting contracts for, and of constructing, highway bridges have been of such character as to invite unscrupulous contractors in many instances, and to foster the idea that the best work was not necessary. It is also well known that the contractor often makes little effort to fulfill the intent of the specifications. Indeed, if an effort is made to compel the fulfillment of the contract and specifications, such a contractor is apt to feel that he is being imposed upon. The writer has had several years' experience with one of the large corporations, and has been engaged to some extent in the inspection of the erection of small steel highway bridges.

It is the exceptional case where any attempt is made to inspect the steel before it leaves the fabricating plant. Usually no one who represents the buyer, or the public, looks over the bridge to determine whether it fulfills the contract or not until the bridge is practically complete. This is a serious mistake, for there are many little details (and some of considerable consequence) that could be remedied easily at the shop, but are difficult and expensive to remedy in the field. The fact that the bridge is erected, and any changes are expensive, will usually cause the inspector to hesitate in requiring changes unless they are very necessary. For instance, some lacing bars ¼ in. thick were used on a bridge where $\frac{5}{16}$-in. bars were required. In another case, the same size of Lomas nuts was used for 3-in. and 3¼-in. pins. The nuts were standard size for the 3-in. pins, but for the larger pins the recess in the nut was not of sufficient diameter to pass over the shoulder of the pin.

In another case, the specifications required that all finished surfaces should

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be painted with white lead and tallow before leaving the shop (this note was also on the shop drawing), and that the masonry and shoe plates on which expansion rollers moved should be planed. The pins were not painted and had become quite rusty, the rollers had been painted with some kind of heavy black paint, and the masonry and shoe plates had not been planed. On this same bridge (120-ft. span), the counters in the trusses were adjustable. In order to have the required net section the screw ends should have been upset, but they were not.

On a five-panel 82-ft. pony truss span the shop drawing showed the two end panels of each of the trusses riveted up complete and the members of the middle panel field riveted. Instead, it was sent out with no two members riveted together. All riveted joints on the two end panels had been computed for shop rivets. The inspector did not see the bridge until it was erected and the field rivets driven, and only discovered it then because the field rivets did not have good heads and had not been painted. The specifications under which the bridge was constructed required that the allowable shear on field rivets should be 80% of that on shop rivets. This one item reduced the efficiency of this new bridge to 80% of what it should have been. Very seldom is the anchorage properly provided for. Often the detail of the shoe is such that it is impossible to drill the holes or enter the anchors. Many times no slotted holes are provided at either end for expansion. Sometimes slots are punched in all four shoes and neither end is fixed. The anchor bolts often furnished are nothing more than a round bar with a hook bent on one end.

Shop inspection is essential to the securing of first-class work. Where the work does not conform to the specifications changes can be demanded, the contractor cannot complain that it is an unnecessary hardship, and the inspector does not need to hesitate in making his demands.

Many of the weak points in small steel highway bridges which are due to methods of erection or field work, can be traced to the ignorance or carelessness of the foreman, or to a desire on his part to cheapen the cost of the erection or to save time. Poorly driven rivets are to be found on practically every job. Well driven rivets require both care and experience, qualifications which are likely to be lacking in the foreman on this kind of construction. It is not unusual to find rivet holes filled with cement and painted over. Turned bolts as actually furnished are machine or pressed bolts turned down, not to a driving fit as required by the specifications, but about $\frac{1}{16}$ in. smaller than the rivet holes.

The packing of pins in a pin-connected span may be carelessly done. Sometimes the bars are not packed in pairs and symmetrical with the center line of the truss, so that a much greater bending movement may be put on the pin than it was calculated to receive. Quite often no sketches are shown on the drawings to indicate in what order the bars are to be placed on the pins. If the foreman can find any way to avoid placing collars on the pins to keep the bars in their proper places, he will usually do so. In fact, it usually requires a forceful statement from the inspector to the effect that they shall go on, before the foreman even considers the possibility of putting them on. Field painting is seldom properly done, and the dirt will not be cleaned off the steel unless the men are watched very closely.

It is not unusual to find weak details on highway bridges. This, of course, is the work that is designed in the office. A common point of weakness is the connection of the floor beam to the post, which is lacking in rigidity. Sometimes the post is so detailed at this point as to materially reduce its efficiency in taking compressive stresses. For example, the post may be made up of two channels laced and the floor beam is suspended below the bottom chord. The channels are cut off above the bottom chord eyebars to clear the eye-bar heads, and only narrow plates are extended down to carry the floor beam.

It is a common occurrence to find that no provision had been made to carry the outside end joists where they come close to the shoe and cannot rest on the masonry. If this has not been provided for in the shop it must be taken care of in the field. Shop drawings for these bridges are not carefully checked as a rule, hence the mistakes are found in the shop and in the field and must be corrected.

If first-class work is desired, some modifications must be made in the method of handling steel highway-bridge construction.

1. In states having highway commissions the highway engineer should get out standard shop drawings for all spans in common use. The drawings should be carefully checked, all poor details eliminated and all mistakes corrected.

2. All fabricated material should be carefully inspected by an experienced man before being shipped from the fabricating plant. This would eliminate all shop errors, intentional or otherwise, and should provide first-class work to go into the field.

3. The work should be carefully inspected in the field after erection and before its acceptance.

4. All companies bidding on this class of work should be given due notice of what to expect so there could be no complaint of its enforcement.

5. There is only one price basis fair to both parties concerned, and that is a pound price basis.

6. The bids should be called for, not for a single bridge at a time, but for the steel bridges for the entire state for a full year, on a pound price basis, bids being called for on each class of work, with a maximum and minimum tonnage to be ordered under those bids. An objection to this system might be that it would eliminate the small bridge companies. But economy should be practiced in public as well as private affairs and it is certain that private corporations would not use the methods that have been in vogue generally in the management of public business. If the small bridge companies can do as good work at the same price as the larger concerns, they would not necessarily be eliminated.

Some of the above suggestions would necessitate the enactment of new laws in most states. Also the appropriation of more money than is now given for this work. First-class work will not be obtained on highway bridges until the public demands it, and business methods are adopted by which it can be determined whether first-class work is being furnished or not. This is being done in Illinois by the Highway Commission, just as far as means and opportunity furnished to it will permit.

The Commission Plan of City Government for Buffalo, N. Y., is authorized by a bill recently introduced in the New York Legislature. The bill provides for a mayor, at a salary of $7000 a year, with no veto power, and four council men with salaries of $6000 a year each. The bill seems to follow the regulation commission plan in most respects, but, while it contains provision for the referendum, it seems to have no provision for either the initiative or the recall. All franchises for public utility companies passed by the council must be subjected to referendum vote without awaiting for petitions. By virtue of his office, the mayor would be at the head of the Department of Public Safety, which would include the subdepartments of Police, Fire and Health. The council as a whole would designate which one of the remaining four members should head the Departments of Finance and Accounts, Public Affairs, Public Works and Park and Public Buildings. The Department of Public Works would include the four existing bureaus or departments in charge of public works until this order was changed by the council. The schools of the city, or public instruction, would in the same way be vested in the Department of Public Affairs until otherwise ordered by the council. The council would be vested with all the present executive and administrative powers of the city, and would appoint all elective or appointive officers except those pertaining to the City Court, Civil Service and the present Grade Crossing Commission.

Electrical Symbols for Mine Maps

A system of symbols for electric mine apparatus as recommended for general practice in recording the results of examinations, etc., was shown in a paper read by H. H. Clark, electrical engineer of the U. S. Bureau of Mines, before the Coal Mining Institute of America and the Northeastern Pennsylvania Society of Engineers, Dec. 20, 1911.

The list resembles in a few particulars one prepared by the National Electrical Contractors Association and approved by the American Institute of Architects (see ENGINEERING NEWS, Oct. 11, 1906, and Oct. 17, 1907). As many of the symbols as seemed applicable in the previous code noted were used, and as far as possible the other characters are those which have been quite generally used in electrical diagrams. However, many are quite arbitrary forms.

It was found easy and simple to select characters for apparatus and machinery, but the representation of conductors on the map was more difficult. With only one or two conductors in an entry, they could be shown on large maps by lines of different colors or different arrangements of dots and dashes. But where there were many connectors and the scale of the map was small this practice was not found satisfactory. Therefore, except for detail maps, lines have been omitted, and letters are used to indicate the presence of conductors: Thus *T* denotes a trolley wire, *C* a bare low-voltage conductor, and so on, as shown in Fig. 1. Figures are used with the letters to denote the number of conductors: thus 2*T* denotes two trolley wires, and 3*C* shows three bare conductors. These letters are placed on the map along the side of an entry to show what circuits are passing through that entry. Whenever a conductor is added or dropped a new symbol is put on the map at that place showing one more or one less as the case may be.

Where there is room for lines, it is suggested that the use of letters as outlined above may be supplemented by a single colored or dotted line, which shall extend everywhere the electric wiring extends. The mere presence of electric wiring would be shown by this line; the extent of the equipment would be learned from the symbols at the side of the entry.

Examination of Fig. 2 shows the application of the U. S. Bureau of Mines' code to an actual case.

This mine uses a great deal of electrical apparatus and it is necessary to use about 30 symbols. It is assumed for the purpose of illustration that power is taken from an underground substation at which point is installed a 300-kw. rotary converter fed by 350-kw. transformers. The symbols show a high-

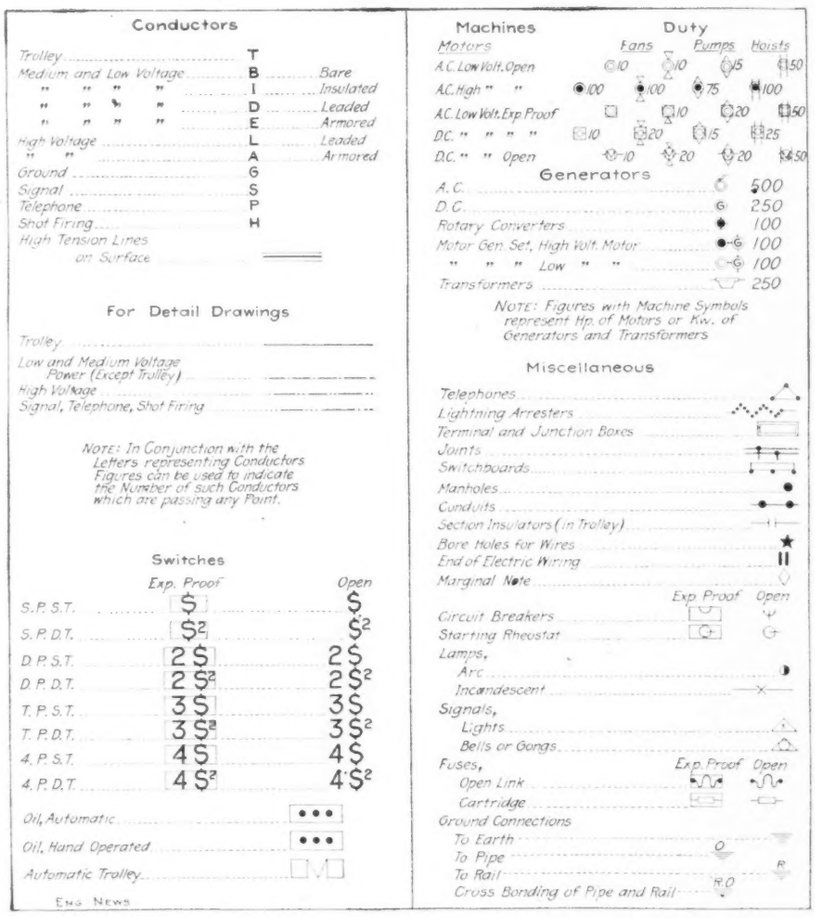


FIG. 1. U. S. BUREAU OF MINES CODE OF ELECTRICAL SYMBOLS

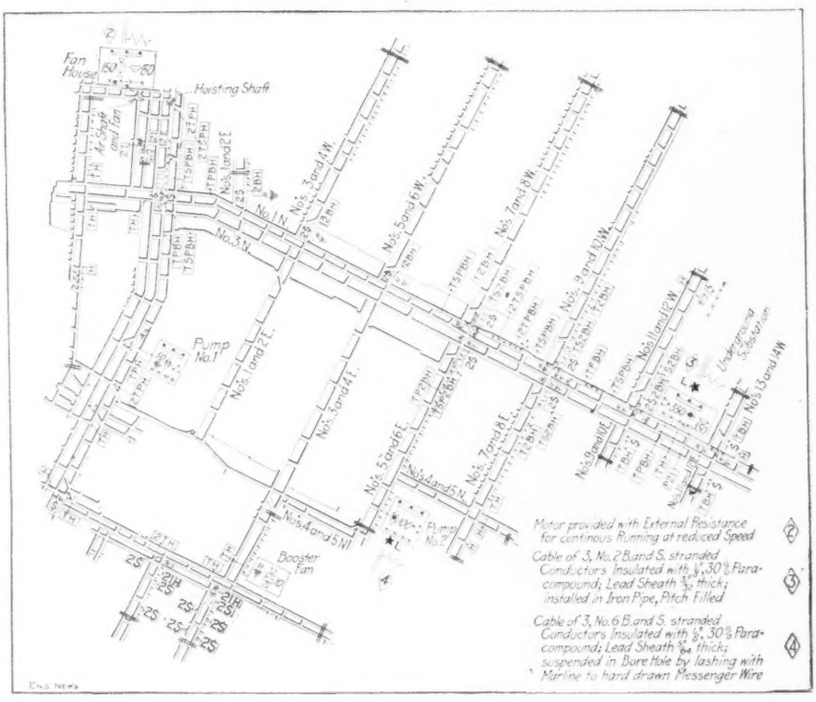

Fan House
Hoisting Shaft
Air Shaft and Fan
Pump No. 1
Booster Fan
Underground Substation
Motor provided with External Resistance for continuous Running at reduced Speed
Cable of 3, No. 2 B. and S. stranded Conductors Insulated with 3/64" 30% Para-compound; Lead Sheath 1/16" thick; installed in Iron Pipe, Pitch Filled
Cable of 3, No. 6 B. and S. stranded Conductors Insulated with 3/64" 30% Para-compound; Lead Sheath 1/16" thick; suspended in Bore Hole by lashing with Marline to hard drawn Messenger Wire
ENG. NEWS

FIG. 2. ELECTRICAL SYMBOLS ON A MINE MAP

voltage lead-covered cable going down a bore-hole to the substation. This cable receives its power from an overhead transmission line and is protected by a lightning arrester. Marginal note No. 3 gives some additional information about this cable. In the underground substation, besides the transformer and the rotary converter, are a switchboard, a telephone and four incandescent lamps.

The mine is shown with an electrically operated fan. At the fan house, the symbols show a high-voltage transmission line, lightning arresters, a 150-hp., low-voltage alternating-current motor, a 150-kw. transformer, switchboard, and four incandescent lamps. Marginal note No. 2 gives some additional information regarding the motor.

In pump room No. 1 are seen a 50-hp. direct-current open-type motor, switchboard, telephone and four incandescent lamps. There is also a symbol which shows that the return circuit of the motor is grounded to the pipe line leading from the pump. The machinery in pump room No. 2 is similarly designated.

Signal lights are shown at almost every junction of a slide entry with the main haulage way. Automatic trolley switches, or section insulators with single-pole switches, are used on every side entry where motors are operating. This mine is supposed to use a system by which shots are fired from the surface and the shot-firing lines are carried to the face of all entries. Dotted lines for showing presence of electrical conductors have not been used.

Starting from the hoisting shaft and working toward the inside of the mine, the symbols show that there are two trolley wires, a telephone wire, and a shot-firing line running along the main entry. The second symbol shows that a signal line has been added for operating the signal light in No. 1 north. As we turn into No. 1 north at its junction with the main entry, the first symbol shows that a trolley line, a signal circuit, a telephone circuit, a bare low-voltage conductor, and a shot-firing circuit are running down this entry. The next symbol marks the point where the signal line is dropped. At the entrance to No. 4 west and No. 6 west the symbol *2BH* shows that two bare low-voltage conductors are installed in these entries. The next symbol on No. 1 north, which occurs between No. 6 and No. 7 west, indicates that the signal wire has been picked up. At the entrance to No. 8 west a symbol shows that the trolley wire, a signal line, two bare conductors, and a shot-firing line are carried up this entry. The next symbol shows where the signal line is dropped. The remainder of the conductors are carried on to the "stop" symbol put outside the last crosscut on this entry. The next symbol on No. 1 north indicates the double trolley line at the parting, the signal line for No. 8 west and No. 6 east, a telephone line, a bare feeder, and a shot-firing line. The next symbol shows the dropping of the signal line. Following this there is a symbol which marks the end of the double trolley and the beginning of the signal line for No. 10 west and No. 8 east. Beyond this point in the following order *TPBH* marks the end of the signal wire, *TSPBH* indicates the beginning of another signal wire, which in turn is dropped at the next symbol *TPBH* just before reaching the substation. The symbol *TH* shows that both the telephone line and the bare feeder have been dropped. Just beyond No. 14 west the symbol *H* marks the end of the trolley while the shot-firing line is carried to the stop mark near the face.

Municipal Limitations on the Height of Buildings

An inquiry as to municipal limitations on the height of buildings in American cities was made by the Commission on the City Plan of Hartford, Conn., a year or so ago. The results of the inquiry are given in the report of the Commission for the year ending Mar. 31, 1911, which has just been issued. Of 30 cities listed, 19 had no ordinance governing the height of buildings. These cities were as follows:

Albany, N. Y.
Atlanta, Ga.
Cincinnati, Ohio.
Dayton, Ohio.
Milwaukee, Wis.
Minneapolis, Minn.
Newark, N. J.
Paterson, N. J.
Philadelphia, Penn.
Reading, Penn.
Nashville, Tenn.
Richmond, Va.
San Antonio, Tex.
Spokane, Wash.
Salt Lake City, Utah.
Syracuse, N. Y.
Tacoma, Wash.
Toledo, Ohio.
Trenton, N. J.

The ordinance provisions of the 11 other cities, as abstracted or quoted in the report just named, are as follows:

Baltimore, Md.—No building more than 175 ft. high except that towers, spires and belfries in fireproof buildings may extend to a greater height.

Boston, Mass.—No ordinance, but building laws provide the following: City divided into districts. District A, buildings of fireproof construction can be erected to a height of 125 ft., in another district the height of 100 ft., in a third, 80 ft., but the buildings in these latter districts are not of the same construction as District A.

Buffalo, N. Y.—"Outside of the fire limits of the city of Buffalo it shall be lawful to erect frame buildings not exceeding 50 ft. in height from the sidewalk to the highest point of roof."

Cleveland, Ohio—"No building or other structure hereafter erected except a church spire, shot tower, water tower or smokestack, shall be of a height exceeding two and one-half times the width of the widest street upon which building faces, but no building shall be over 200 ft. high."

Denver, Colo.—"No building or structure to exceed 12 stories excepting spires, towers, smokestacks, etc. All buildings or structures more than 125 ft. high, absolutely fireproof."

Los Angeles, Calif.—Fire district one story only and not over 16 ft. high.

Class A. All buildings upheld by masonry or reinforced concrete or framework of steel or iron. Fireproof or skeleton construction. No building over 150 ft. allowing 30 ft. for mansard roof—not more than seven stories.

Class B. Masonry or masonry and steel, and iron or steel buildings, supporting iron or steel masonry. Not over 100 ft. high nor more than eight stories.

Class C. Masonry or reinforced-concrete walls, floors not wholly carried by steel columns, and girders or reinforced concrete or masonry—85 ft. high, not more than six stories exclusive of basements.

Class D. All buildings not included in A, B and C, 50 ft. high, not more than four stories.

Louisville, Ky.—No nonfireproof building or structure outside the fire limits shall exceed 70 ft. in height, but this shall not apply to spires of churches or similar buildings outside of the fire limits which may be constructed of wood to a height of 125 ft. above curb level.

Portland, Ore.—

Class I (absolutely fireproof), 12 stories or 130 ft.
Class II (fireproof, short span), 12 stories or 160 ft.
Class III (fireproof, long span), 10 stories or 140 ft.
Class IV (semi-fireproof), 6 stories or 85 ft.
Class V (mill construction), 6 stories or 85 ft.
Class VI (ordinary construction), 4 stories or 60 ft.
Class VII (frame construction), 3 stories or 42 ft.

Providence, R. I.—No ordinance. Building law provides, "No nonfireproof building or structure hereafter erected should exceed 65 ft. in height."

"No fireproof (ordinary) building or structure hereafter erected shall exceed 120 ft. in height except that structures or appendages may be built upon roofs of said buildings not exceeding 20 ft. in height, provided that said structure or appendages shall be built of incombustible material throughout."

"Every building hereafter erected or altered to be used as a theater or public station which exceeds three stories or more than 40 ft. in height, shall be built fireproof (absolute) except as hereinafter specified."

Rochester, N. Y.—No ordinance. Height regulated to conform to size and strength of foundations and construction of walls.

San Francisco, Calif.—Fireproof buildings, 102 ft.; semi-fireproof buildings from 55 to 86 ft.

Pneumatic "Springs" for Automobiles

The springs ordinarily fitted on automobiles are not materially different from those in use for years on horse-drawn vehicles. The higher speed of the motor vehicle, however, increases the work put upon the springs. The difficulty is, with the usual elliptical springs, that springs made stiff enough to withstand the loads imposed at high speed are too stiff for the best comfort at any speed.

Mr. George Westinghouse has been at work for a number of years upon a pneumatic cushioning device to take the place of springs on motor vehicles. This device, as now offered to the public, is shown in the accompanying illustrations, Figs. 1 and 2, taken from an announcement recently issued by the inventor.

The general appearance of the air spring, as it is termed, is shown in Fig. 1, which makes plain the manner of attaching it to an ordinary car equipped originally with semi-elliptic front and three-quarter elliptic rear springs. It will be noticed that the steel front spring and the lower part of the steel rear spring are retained. It is explained in the inventor's announcement that while the riding qualities of cars equipped with the air spring alone were all that could be desired, the method of applying it in combination with the steel springs, as shown, is more convenient, particularly when applying it to cars already in use with steel spring equipment. At the same time, the cushioning effect of the combination was found more satisfying than that of the air spring alone.

The air spring consists essentially of two hollow cylinders, or cups, sliding one within the other. The open ends of the two cups are placed toward each other, so that they form together an enlarged capsule, inclosing a volume which becomes smaller or larger as the two members are telescoped together or drawn apart.

The first problem to be met in making such a device practical is that of air leakage. This must be reduced to a practicably negligible minimum; otherwise the necessity for frequent renewal of the air contents would become a tedious nuisance. The difficulty of doing this is at once apparent upon considering that, since four 3-in. cylinders sustain a car of 3500 to 6000 lb. in weight, the air pressure is 125 to 200 lb. per sq.in. with the car standing and becomes much higher when the springs are further compressed with the car in motion over rough roads.

The first step in eliminating the air leakage was to fill the lower part of the "capsule" with oil. The upper cup, of the pair making up each spring, is the smaller and slides inside the lower cup. Thus any leaking air must pass around under the lower edge of the upper cup and up between the two cylinders. By making the depth of oil sufficient to cover the open lower end of the upper cup in its highest position, the cushioning chamber is at all times oil-sealed. This only means, however, in view of the high pressure, that there is oil leakage instead of air leakage to be prevented.

The most important feature of the invention, therefore, is the ingenious device whereby the leakage of oil is reduced, it is claimed, practically to zero. This device is shown in Fig. 2. From the view at the left in this figure, which shows a vertical section through a single complete air spring, it can be seen that the lower end of the inner cup is partly closed by a complicated-looking piston, or dasher. It is more properly called a dasher since it has a considerable opening through it to permit the passage of oil. This dasher is fixed to the upper cup and moves up and down with it through the oil which fills the lower part of the chamber.

The construction and operation of the dasher are made clearer by the detail view at the right in Fig. 2, showing it on a considerably larger scale. The air spring, as already explained, is normally filled with oil to a height sufficient to cover this dasher, so that the packing is completely oil-sealed. *P* and *Q*, in the figure, are plain leather packing rings, and

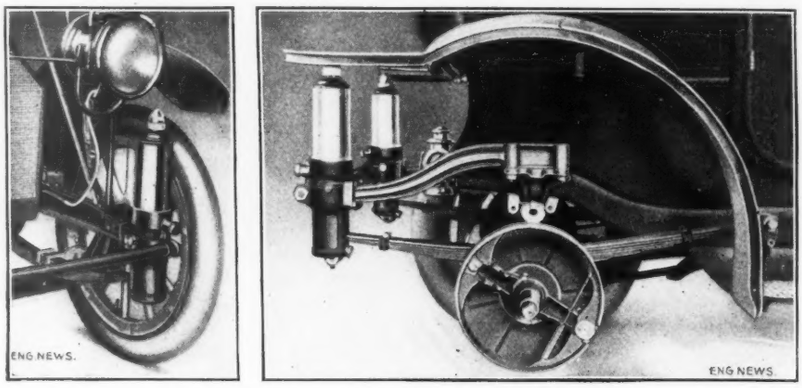


FIG. 1. WESTINGHOUSE AIR SPRING AS APPLIED TO AN AUTOMOBILE
(In the view of the rear springs, at the right, one wheel has been removed to show the method of attaching the bracket, which takes the place of the upper member of the steel spring.)

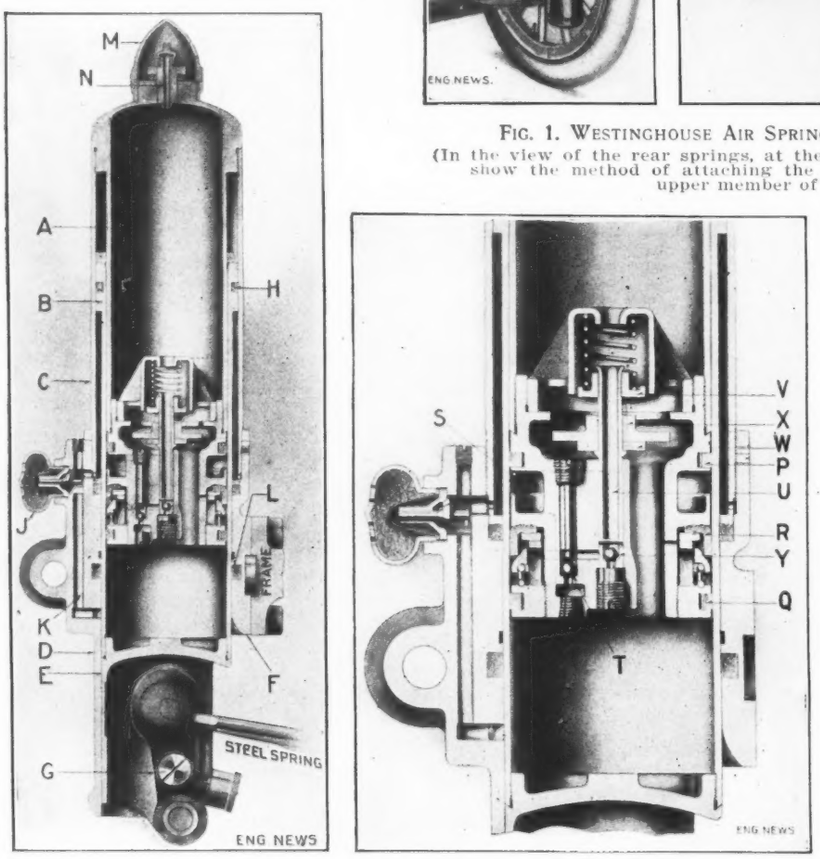


FIG. 2. SECTIONAL VIEW OF AIR SPRING WITH ENLARGED DETAIL OF DASHER

R is a cup-leather packing set out by means of a conical ring and springs. It is impossible to make these packings absolutely oil-tight, and in fact a small amount of leakage is desirable to insure proper lubrication. But the small amount of oil that gets past the ring *Q* and the cup-leather *R* is trapped in the annular chamber *S*.

This chamber *S* is in effect the suction well of the small single-acting pump *U*, which returns the oil that has passed the packing rings back to the main cushion chamber. From *S*, the oil passes on its way to the pump through a vertical passage, indicated in Fig. 2 by dotted lines, to the space beneath the ball valve *T*. From this space it is drawn into the pump cylinder by the up stroke of the hollow plunger *U*. During the following down stroke of this plunger, the oil just drawn in is forced up through the ball check valve *Y* and is discharged through the plunger itself back into the main cushion chamber.

The power for driving the pump plunger is derived from the flow of oil through the air-spring dasher when the spring is in action. Compressing the spring forces the upper cup down into the lower, so that the dasher attached to the upper cup is moved downward through the oil. The result is equivalent to a current of oil passing upward through the dasher. This current acts upon the disk *X*, which is free to slide on the upper end of the pump plunger. The diameter of this disk is such that it would almost fill the passage through the dasher at the constricted opening shown just above the disk in Fig. 2.

The upward current of oil, as the dasher descends, carries the sliding disk *X* up against the collar *V*, which is fixed to the pump plunger. As the disk rises further, it carries the plunger with it and gives the suction stroke of the pump. When the air spring is extended again after compression, the dasher rises, the current of oil passes downward and the disk *X* is carried down against the lower fixed collar *W*, forcing the pump plunger to the bottom of its discharge stroke. The pump plunger is held normally at the bottom of its stroke by a high spiral spring pressing on the collar *V*.

Besides its usefulness as a device for reducing the leakage, the dasher serves another important purpose. By its movement up and down through the oil, which has to pass at increased velocity through the constricted opening, a dashpot effect is developed which damps the vibration of the spring like the mechanical shock-absorber used with ordinary springs.

In the view at the right in Fig. 2, it is shown that the upper air-spring cup has a double wall. This arrangement gives protection from dust and mud and makes possible the use of a device called the "breather," shown at *J* in the cut, which consists of an air inlet valve covered by a perforated cap filled with filtering material. Compressing the air spring draws air through the breather into the annular space between the tube *B* of the lower cup and the outer dust-guard tube *C*. When the spring extends again, this air is forced down through the passage *K* and is blown out through the unpacked space between tube *B* and the steel guide casting *D*, thus preventing the entrance of grit and dirt at this point.

The felt wiper ring *L* gives further protection from dust and prevents the escape of lubricating grease from above. The circular projection just below the breather valve is a connection for the tie rod or distance piece between the two front or rear springs.

The reason for the superiority of the air spring, in theory, over the ordinary steel spring is revealed in Fig. 3, which shows curves plotted between load and displacement, or travel, of the spring. From theoretical considerations, these curves should be hyperbolas, and the curves plotted from actual tests seem to approximate this form. But the important point to be noticed is that they are curves of a shape which indicate an easy spring action near the normal load position, with rapidly increasing stiffness when the load is very much increased.

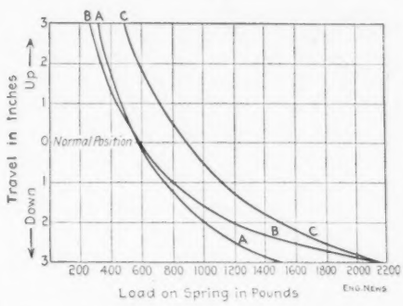


FIG. 3. LOAD-TRAVEL CHARACTERISTICS OF THE WESTINGHOUSE AIR SPRING

(Curves A and B show the spring action, with the same initial air pressure at mid-position, but with different depths of oil in the cushion chamber. Curve A was obtained with the minimum depth of oil; Curve B with a considerably greater quantity. Curve C was obtained with medium depth of oil and greater air pressure.)

The steel spring, as ordinarily built, has a load-displacement characteristic which is approximately a straight line. Therefore the slope, which represents the stiffness, has to be as great at normal load as is required for the maximum load the spring can safely sustain.

The action of the air spring can be regulated to suit the requirements of the user by changing the initial air pressure or by varying the depth of oil in the cushion chamber. The effect of such changes is shown by the different curves in Fig. 3. The initial air pressure of the desired intensity is obtained with an ordinary tire pump connected to the air valve *N*, shown covered by the screw cap *M* in Fig. 2.

Mr. Westinghouse has arranged to have the air spring manufactured by the U. S. Rapid-Fire Gun & Power Co., of Derby, Conn. President C. H. Williams, of that company, will act as general agent for the sale of the springs. They are made in three sizes, with cylinders of 3-in. diameter for cars weighing 3500 to 6000 lb., 2½-in. diameter for 2500- to 3500-lb. cars and 2-in. diameter for lighter cars.

The inventor states that the air spring has been subjected for three years to severe tests on a number of cars of different weights, one car fitted with these springs having covered a distance of 10,000 miles over all sorts of roads during the spring and summer of 1911 alone. It is claimed that the annual saving in wear and tear on the car, and especially on the tires, will approach the first cost of the equipment.

The Witwatersrand Gold Field, South Africa, from its discovery in 1886 to the end of 1910, has produced gold to the value of £276,000,000, equivalent to nearly $1,345,000,000. This gold has been obtained from 156 million tons of ore, being an average yield of a little less than $9 per ton. During the year 1910, the gold produced reached a value of nearly $150,000,000 and the average gold production per ton of ore was about $7. The average cost of mining and milling the ore, including all costs in connection with the operation of the mines, was about $4.25 per ton of ore treated. Some of the large producing mines, however, reduced these costs below $3 per ton. The output of the mines is largely dependent upon the supply of native laborers, which supply never has been equal to the demand. Nearly 100,000 natives were at work in the mines before the outbreak of the Boer War in 1899. Several years were required, after the declaration of peace, to reorganize the working forces, and it was not until 1905 that the number of natives at work equaled that in 1899. Since then, however, the number has been largely increased. Last year the number employed reached nearly 200,000, and additional labor is needed to provide the rapid increase in output which is projected. The above figures are taken from a "James Forrest" lecture delivered by Dr. F. H. Hatch at the Institution of Civil Engineers. Dr. Hatch's paper contains an estimate of the probable life of the Rand gold fields if the ore is worked out to a vertical depth of 6000 ft. below the surface. One of the largest mines is already working at a depth of 4000 ft. Dr. Hatch estimates that there is still over $5,000,000 of gold remaining above the 6000-ft. level in the Rand gold field. This would give the mines a future life of 35 years on an average output of $150,000,000 worth of gold per year. The geological investigations indicate, however, that the gold-bearing rock may extend to a depth of 7000 or 8000 ft. or more, and Dr. Hatch thinks it is within the possibilities that the ore may be profitably worked even at this great depth.

Large Manganese Steel Dredge Pump in Use on New York Barge Canal

The centrifugal-pump casing shown in the accompanying illustration consists of a single casting of manganese steel. To facilitate machining, soft-steel inserts were cast in around the outlet flange and the side-plate circle at the points where stud or bolt holes were required. There are 16 drilled holes in the outlet flange and 108 tapped holes for the studs by which the suction and back heads are attached. The casting was machined by grinding at the surfaces where a finish was necessary. The grinding was done on a machine having a swing of 16 ft. 9 in.

The cut shows the casing finished and ready for installation. Its outside diameter is 10 ft. 9½ in., width 28½ in. and wall thickness 3¼ in. The weight of the

MANGANESE STEEL CASING FOR A LARGE HYDRAULIC DREDGE PUMP

casting, 16,300 lb., and its none too simple shape must have called out the best efforts of the foundrymen. The runner, or impeller, for the pump is also a manganese-steel casting. It is 6 ft. 6 in. in outside diameter and 20 in. wide, weighing 6850 lb.

Both casing and runner were made by the Taylor Iron & Steel Co., to whom we are indebted for the information and photograph. The pump is now installed on the dredge "Stanwix No. 21," operating on the New York State Barge Canal.

Besides its superiority in resisting the abrasive action of grit and sand, the manganese steel is stronger against fracture from the blows given by large pieces of stone or other material drawn up by the pump. It is claimed that the use of manganese steel for the wearing parts will increase their life to about three times that of ordinary steel castings.

Annual Meeting of the Canadian Society of Civil Engineers

The annual meeting of this society, held at Montreal, on Jan. 24 and 25, was attended by nearly 200 members. The annual report of the society's council showed a total present membership of 2882; of these, 562 are members, 1083 are associate members and 1130 are students. The increase during the year was 143. Local branches of the society have been organized, and are in active operation at Vancouver, Winnipeg, Toronto, Ottawa, Kingston and Quebec.

The annual address was delivered by C. H. Rust, president of the society during the past year. Mr. Rust's address related chiefly to municipal engineering work in Canada. He referred to a bill before the Dominion Senate, which entirely prohibits the disposal of sewage by a municipality into any body of fresh water. Mr. Rust deprecated such legislation, and pointed out that it would cause a great hardship to many cities which would be unable, for financial reasons, to install sewage-disposal plants. Even were such plants universally installed, they would not purify the stream. Freshets yearly wash into the streams from streets, roads and farmyards large accumulations of filth.

A remarkable accident, which occurred to the Toronto water-works intake in the winter of 1911, was described by Mr. Rust as follows:

> Toronto is supplied with water from Lake Ontario through a 6-ft. riveted steel pipe, made in lengths of between 150 ft. and 160 ft., and bolted together with cast-steel flanges.
>
> Early in February a very severe storm from the east occurred, which filled the lake, as far as the eye could reach, with large quantities of floating ice, while ice banks 30 or 40 ft. high also formed along the shore.
>
> On the 7th of the same month difficulty was experienced in obtaining a sufficient supply of water, and, on examination of the shore crib, a great many branches of trees and other débris were discovered. During the night all the pumps were closed down, and then started up, with the expectation that this would remove the obstruction. This method, however, proved unsuccessful. Divers were then sent down into the pipe where a log, 12 in. in diameter and 12 ft. long, was found, as well as other small pieces of timber and a large accumulation of sand. Steps were immediately taken to have this sand removed by pumping, using a centrifugal pump. The supply of water to the city was entirely stopped and had to be obtained directly from the Toronto Bay.
>
> Upon a further examination of the pipe it was found that about 600 ft. from the shore there was an opening of about 4½ in. in one of the joints, only 10 bolts being left out of 40. Four other breaks were found in the pipe line, three pipes being entirely separated, all bolts removed and a great many of the rivets sheared off, making it necessary to have these pipes lifted and taken to the city for repairs. The 4½-in. opening, however, was repaired by putting in a tapered wooden gasket. Piles were then driven close together on each side of the pipe and the space filled in with concrete. The work of removing the sand from the pipe was one of considerable difficulty. We are now driving steel sheet piling on either side of the pipe for a distance of 1200 ft. from the shore, leaving a space of about 1 ft. between the pipe and the piling, and filling this space with concrete. The total cost of making these repairs will be nearly $100,000.
>
> As a test of the efficiency of the hypochlorite of lime treatment for water purification, it may be pointed out that during the period of some weeks, when the city was using polluted water from the Toronto Bay, no considerable increase in typhoid occurred. Without this plant no doubt Toronto would have had a most appalling epidemic of typhoid.

The rapid growth of Canadian cities and the consequent necessary large expenditure in the attention of municipal utilities was summarized by Mr. Rust in the following statistics, giving the work done in the past 10 years in the cities of Winnipeg, Montreal and Toronto:

City	Miles of pavements	Miles of sidewalks	Miles of sewers	Miles of water mains
Winnipeg ...	85	266	135	144
Montreal	37	120	114	40
Toronto	251	410	70	114

The committee having in charge the award of the Gzowski medal reported in favor of the award of the medal to W. G. Chace, for his paper contributed to the society on the municipal hydro-electric works for the city of Winnipeg.

The report of the society's committee on conservation was presented by James White, who is the secretary of the Conservation Commission appointed for the Dominion Government. This commission has under its organization seven different committees, dealing, respectively, with waters and water powers, minerals, forests, fisheries and game, lands, public health and press and coöperating organizations. The committee on forest preservation has concentrated its work on the prevention of fires. At the last session of Parliament, the Railway Act was so amended as to make railways liable for damages caused by locomotive sparks, whether negligence by the railways could be proved or not. The liability for damages is limited to $5000, however, if modern and efficient fire-prevention appliances are used.

The report of the committee on the establishment of testing laboratories was submitted by C. H. Keefer, chairman. The committee made an investigation of the cost of equipping and maintaining other government testing laboratories, especially that at the U. S. Bureau of Standards in Washington, in charge of Col. J. E. Howard. Mr. Keefer reported that the matter of establishing a Canadian Government laboratory had been taken up with the Dominion Government officials, but that owing to the change in

party control nothing definite could as yet be done.

In the evening the visiting members attended an address by Dr. H. T. Barnes on "Iceberg Detection in Navigation," in the Lecture Hall of McGill University. Doctor Barnes is the inventor of instruments for detecting microscopic differences of temperature. An iceberg floating in salt sea water produces a layer of fresh water which, being lighter than the salt water, spreads over the surface of the sea for a considerable distance. Doctor Barnes hopes that his instruments for detecting minute differences of temperature will be able to detect the proximity of an iceberg some time before a ship reaches it. Tests of the method are to be made during the coming summer by the Canadian Department of Marine.

On Thursday the members visited the Angus shops of the Canadian Pacific Ry., and the works of the ominion Bridge Co. and of the Canadian Car & Foundry Co. In the evening the annual dinner was held at the Windsor Hotel.

The society has recently received an offer for the building in Montreal in which its headquarters have long been located. The offer comes from a railway company which is proposing to enlarge its terminals. At the session on Friday it was voted to accept the offer of $60,000 which has been made for the building, and to authorize the society's council to purchase a site and erect a new building for the society at a total expense not greater than $100,000.

The reports of the various standing committees of the society were taken as read without discussion. It was voted that a special committee of the society should be appointed to confer with the Dominion Senate with reference to the pending bill prohibiting the discharge of sewage into fresh water. The letter ballot for election of officers resulted in the choice of W. F. Tye as president for the ensuing year.

Letters to the Editor

Re-Rolled Rails for Reinforcement

Sir—On p. 101 of your issue of Jan. 18, 1912, in the "Regulations for Concrete Buildings, Cleveland, Ohio," under the heading of *Steel*, I notice that reinforcing bars may be rolled from *T-rails!*

I wish to say that, in my opinion, this is a very *dangerous* concession to commercial interests. No such material should be allowed.

E. W. STERN.

New York, Jan. 19, 1912.

High-Water Cycles

Sir—Referring to the extract from an address by Allen Hazen, published in your issue of Jan. 25, 1912, the following extract from address which I delivered before the Oklahoma Engineering Society is pertinent; it indicates wet cycles as well as dry:

"Some of us are not aware that a 20- or 30-year record of high water, minimum or maximum flow, or rainfall may often be of comparatively little value. It seems to be a fairly well established rule that it takes fully fifty years to complete an Engineering Meteorological Cycle. This was illustrated, for example, at Topeka, Kan. When the Melan bridge was built over the Kansas River, in 1897, the city engineer's records for 25 years showed a maximum rise of 15 ft. from low water to high water, and the oldest inhabitant, who claimed that he had seen the river go clear out of its banks and flood the entire valley prior to 1850, was deemed to be in his dotage and untrustworthy. In 1903, however, the recorded variation of 15 ft. between low and high water was changed to 28 ft.; asphalt pavements were 6 ft. under water; the oldest inhabitant was vindicated and the river proved what everyone should have known: that the high-water mark, in an alluvial valley which has been built up by sediment dropped by the floods, is necessarily higher than the ground surface of the valley, regardless of the records of the city engineer's office."

H. V. HINCKLEY.

Oklahoma City, Okla., Feb. 5, 1912.

The Strength of "Silica Cement"

Sir—In his article on "The Adulteration of Portland Cement," printed in your issue of Jan. 18, p. 94, Prof. R. C. Carpenter states that "Some fifteen years ago Capt. W. M. McClay . . . took out a patent for the grinding together of portland cement and sand, forming a siliceous mixture which was sold as 'silica cement'."

The patent referred to was issued to Frederick L. Smidth, Apr. 4, 1893, and is numbered 494,763. Capt. W. W. Maclay was connected with the company that manufactured under this patent.

As Prof. Carpenter states, the material was sold as "silica cement," better known as "sandcement." In view of the fact that the material was not sold as portland cement it is questionable as to whether or not it is properly classed as an adulteration. "Sandcement" (in the proportion of 50% portland cement and 50% sand, ground together to an extreme fineness) invariably gave strengths in sand briquettes (one sandcement to three standard sand) equal to the strength of the portland cement from which it was made (one part portland cement to three parts standard sand).

GEORGE W. NEWCOMER,
Vice-Pres., F. L. Smidth & Co.
50 Church St., New York City.
Jan. 22, 1912.

More Concerning Contractor's Guarantees

Sir—In your issue of Feb. 1, Mr. Breithaupt charges me with the statement that "the contractor should hold the purchaser's interests paramount to all others," and calls it "paramount nonsense." While I cannot agree with this view, I wish to correct his error as to my statement, which was that the *reader* should bear in mind that the purchaser's interests should be paramount to all others.

Mr. Breithaupt says, "If an engineer is not competent the purchaser should not employ him." But the fact remains that he *does* employ him. Shall the engineering profession instead of recommending adequate security, stand aside and say, "It serves you right. You should have employed a competent engineer," when in most instances the purchaser does not know how to determine whether or not an engineer *is* competent? Why is it that such a guarantee appeals so strongly to the business man and is so often opposed by engineers? I quote from a letter written by a state highway engineer:

> We have been criticized for our stand when we have compared bridges on the basis of the material used in each, the argument of one of the bridge companies being that the supervisors are buying a bridge and not concrete. To use this same argument we believe that the supervisors are buying a bridge and not a guarantee.

Is this sound engineering advice? Is not a guarantee one of the best inspectors that an engineer can employ?

DANIEL B. LUTEN.

Indianapolis, Ind., Feb. 3, 1912.

[If the purchaser does not know how to find a competent engineer, why should not the engineering profession create some organization to aid him?

Let us not make the mistake of overrating the value of a guarantee. An automobile manufacturer may "guarantee" his cars, meaning that any part which proves defective will be replaced free of charge. But if one is to ride along a mountain road with a precipice on one side, he will feel safer to know that the steering gear has been made and tested under careful engineering supervision, than he will because of any "guarantee."

It should not be overlooked that a guarantee really costs the contractor very little. Not one in a hundred of the structures which are "skinned" by the builder breaks down, and when an accident occurs, the contractor may "go broke," or his lawyers may find a way to evade payment. The public has a right to demand far greater safety in all its machines and structures than any guarantee can afford; and it must employ competent engineers to obtain such safety.—ED.]

The Railway Accident at Rock River, Wyoming

Sir—The article on p. 73, of your issue of Jan. 11, 1912, entitled "A Wreck Caused by Poorly Placed Switch Stands," contains so many inaccuracies as to make it apparent that the person who wrote it knew but little about the situation; otherwise he would not have undertaken to have misrepresented the matter in order to write on a subject of general interest.

An investigation of this accident was conducted by the superintendent, assistant superintendent, division master mechanic and division engineer, of the division of the Union Pacific R.R. on which the accident occurred, together with Mayor Frank A. Stitzer, of the city of Laramie, and Arnold G. H. Bode, Dean of St. Matthew's Episcopal Cathedral, Laramie, Wyo. It is the practice of this line in all cases of serious accidents to have a careful investigation made by a board of inquiry composed of the above mentioned officers of the division, together with two outside persons prominent in the locality near where the accident occurred, and the findings of such a board are given publicity on the various bulletin boards along our line, as well as through the newspapers.

This system of investigation has been in vogue on this line for a number of years, instituted for the purpose of allaying the common impression that exists in the minds of the public that it is often the case that the facts in connection with accidents are withheld. In each one of such investigations, any member of the board, including the laymen, is expected to make such interrogations of the various witnesses as may be necessary to bring out all the facts. The board determines the cause, and their findings note clearly where the responsibility rests.

The findings of the board in connection with this particular accident read as follows:

We, the undersigned, a board of inquiry, convened at Laramie this 30th day of October, 1911, for the purpose of investigating the cause of a collision between train No. 4 and Extra West 327 at west switch at Rock River about 10:10 a.m., Oct. 28, after hearing all the evidence obtainable from the train and enginemen involved, find:

That the accident was caused by the gross carelessness of head brakeman Robert E. Lee, of Extra 327, who threw the eastbound main-line switch in the face of No. 4, allowing No. 4 to collide with the westbound extra standing on siding.

This accident resulted in the death of the engineer and fireman of No. 4, the injury of the engineer and fireman of Extra 327, the death of a passenger and the injury of a number of other passengers and employees on train No. 4.

The sketch presented with the article in ENGINEERING NEWS above referred to is incorrect, inasmuch as the location of the depot, coal chute and the standpipe as indicated thereon, at the west end of center passing track, is not correct. The depot is actually 500 ft. east of the east switch of the center passing track, and the coal chute is directly opposite these east switches; the yard being so designed that the center passing track can be extended to the present water tank, which is 250 ft. east of the depot.

The article states that the eastbound and westbound main tracks are 16 ft. center to center, whereas they are 26 ft. It also states the distance between switch stands is 4 ft., while it really is 10 ft. 6 in. It further states that the engine of the freight train was facing east, while as a matter of fact it was facing west. It speaks about passenger train No. 4 being westbound, whereas it was an eastbound train.

Criticism in this article in regard to placing switch stands outside of their respective main tracks, or on the outside of the turnout is contrary to good practice and that adopted by many of the principal railroads throughout this country, and if the suggested practice were followed it would result in many derailments due to any irregular bending or breaking of connecting rods and bridle rods, pulling the point away from the main stock rail instead of forcing it up against it, as is the case when the switch is placed on the turnout side.

In view of the above it seems to me that such an article as the one referred to should not have been printed without first giving the railroad company concerned an opportunity to furnish the facts.

CHARLES WARE,
Assistant General Manager,
Union Pacific R.R.

Omaha, Neb., Jan. 23, 1912.

[A similar letter was received from G. F. Maitland, Assistant Superintendent of the Utah division of the Union Pacific, and other letters were received calling attention to the apparent error in the distance between main-line tracks (16 ft.) given in the sketch accompanying the letter which we published.

We regret that publication should have been given to a letter containing such inaccuracies; and it was through an oversight that a proof of the letter was not submitted to the officials of the railway in advance of publication, in accordance with our usual custom in such matters.

The Union Pacific deserves high commendation for its broad-minded policy in undertaking investigations of important accidents by a board on which the public has representation and making public the results of such investigations.—ED.]

Construction of the Original Reinforced-Concrete Grand Stand at Cincinnati

Sir—In your issue of Nov. 23, 1911, reference is made to the grand stand at Cincinnati.

It is stated that this structure was erected by the Ransome Concrete Co. in accordance with what was then known as the Ransome System. Kindly note that the Ransome Concrete Co. was in no way connected with the design or erection of this structure.

RANSOME ENGINEERING CO.,
Per Ernest L. Ransome,
President.

90 West St., New York City.
Jan. 22, 1912.

[The article which contained the statement criticized by Mr. Ransome was written by Clifford M. Stegner, consulting engineer, Cincinnati, O. We therefore referred the above letter to Mr. Stegner, whose reply follows:]

Sir—In reply to the letter of Mr. Ernest L. Ransome, concerning the grand stand at Cincinnati: I have been told by Mr. H. E. Kennedy, formerly an official of the Cincinnati Fireproofing Co., that the structure was built by this concern operating under patent rights of the Ransome Concrete Co. for the use of the Ransome bar and the Ransome system in the State of Ohio. The engineer in charge of the work was formerly connected with the Ransome company.

CLIFFORD M. STEGNER.

Mercantile Library Bldg.,
Cincinnati, O., Jan. 29, 1912.

The Sheyboygan Standpipe Failure

Sir—The description of the standpipe failure at Sheboygan, Wis., in your issue of Feb. 1, is interesting, but it might have gone more into the details of construction.

It is stated that the vertical joints were double-riveted, with a 6-in. lap. This

lap of 6 in. seems to the writer to be excessive even at the bottom of the standpipe and an unnecessary waste of material, especially for the thinner plates.

It is also stated that the rivets in the vertical joints were 2¼ in. c. to c., the distance between the rows being 3 in. It is hardly probable that this spacing was adhered to throughout from bottom to top.

After giving the rivet spacing, but not the diameter of the rivets, the author assumes an efficiency of the joint of 75%. It is not likely that a rivet diameter of less than ⅞ in. was used on the $\frac{9}{16}$-in. plates. Assuming that ⅞-in. rivets were used and that the holes in the plates were punched $\frac{1}{16}$ in. larger in diameter than the rivets, and not making an allowance for the plate which would be damaged around the rivet holes, due to punching, we would have a plate efficiency at the joint of

$$\frac{2\frac{1}{4} - (\frac{7}{8} + \frac{1}{16})}{2\frac{1}{4}} = 0.583$$

This would produce a stress of over 22,000 lb. per sq.in. in the $\frac{9}{16}$-in. plate at the joint.

GEO. M. PEEK.

34 E. Grand Ave., St. Louis Mo.,
Feb. 5, 1912.

Engineer Members of Public Utility Commissions

Sir—The action of the Brooklyn Engineers Club in requesting Governor Dix to appoint an engineer to the Public Service Commission of New York State is well worthy of your recent editorial comment. The argument "Commissioners should be lawyers as engineers can be hired when their advice is required" is unworthy of serious consideration as it is fully answered by reversing the position of the words lawyers and engineers in the sentence quoted.

This was called to the attention of the members of the American Institute of Electrical Engineers in a paper, "The Engineer's Activity in Public Affairs, Public Utility Commissions and Franchise Valuations," read April 10, 1908:

> A perusal of the minutes of the hearings held before state commissions will convince any unprejudiced person that a disproportionately large amount of evidence and testimony is submitted, with consequent unnecessary financial expense and consumption of time for the purpose of explaining terms, apparatus and method of operation and expenditure to commissioners who, in general, should be acquainted with the matters being considered. This and similar evidence surely indicate that the efficiency of the commissions is largely reduced by lack of proper makeup. For this condition of affairs the engineers themselves are partly to blame.
>
> The antiquated notion that every engineering expert is unable to appreciate any question outside of its purely technical significance is disproved by the fact that the success of the engineer is often based on a liberal education with wide experience, giving him a capacity for proper consideration not only of technical but also of commercial and political factors that enter engineering undertakings, and also by the fact that the administrative and executive staffs of many of our largest and progressive organizations are being constantly recruited from the engineering profession. To become president of the Pennsylvania R.R., judging from precedent, one must have, in addition to other qualifications, both a technical education and practical experience in engineering work.

In connection with the action of the Brooklyn Engineers Club, it is perhaps fair to say that the New York Electrical Society, the oldest electrical organization in the country, before any public service commission had ever been appointed in the State of New York, took formal action similar to the Brooklyn Engineers Club and petitioned Governor Hughes to appoint one or more engineers as members of each of the proposed state commissions.

HENRY FLOY.

165 Broadway, New York City,
Jan. 12, 1912.

[The ignorance of engineering matters exhibited by most bodies, representing the government in any of the various phases of the regulations of industrial activities, was well illustrated by C. A. Seley, Mechanical Engineer of the Rock Island Lines, in an address on "Conference Committee Methods in Handling Railway Legislation on Mechanical Matters," before the College of Engineering of the University of Illinois, Jan. 4, 1912.

> . . . during the Sixty-first Congress it was the policy of the railroads, whenever any bill was under consideration relating to railway operation, to present before congressional committees men who from their knowledge and experience could tell exactly what the proposed legislation meant and what the effects thereof would be.
>
> There is no question of the necessity for this procedure. As an illustration, it is a matter of record that it was necessary for one of these witnesses to explain to "a committee" that the water in a locomotive boiler was not contained in the tubes. To this coöperation between congressional committees and witnesses for the railways, may be attributed the fact that such legislation affecting the physical operation of railways as passed the Sixty-first Congress, was intelligent and of a character that it was possible to enforce without testing in the courts.

It is obviously unreasonable to expect that a congressional committee should often include even a single engineer among its members. But the need and the benefit of coöperation with engineers shown in such cases as the above is another argument for the appointment of engineer members on public utility or industrial-regulation commissions.

Mr. Seley's address, it is pertinent to add, describes the formulation of U. S. standards of railway safety appliances and rules for locomotive-boiler inspection. There was, he says

> . . . serious danger that the U. S. Safety Appliance Standards would be formulated without due consideration as to practicability and difficulty of enforcement, and for some time there was very serious question as to whether any coöperation or assistance from the railways would be accepted on the part of those responsible. However, after this principle was established, the proceedings were rapidly conducted and the benefits were so manifest that not only in every case which has occurred since that time has this coöperation been welcomed, but also in many cases it has been sought. . . .
>
> The standards were to apply on all cars built after July 1, 1911, and the Interstate Commerce Commission was authorized to name the time limits in which equipment built before that date should be changed to comply.
>
> The latter equipment, including about 2,500,000 freight cars, was by far the most important feature. It would be comparatively easy to change drawings and specifications for new equipment not yet built, but to go over every old car and make the necessary changes to comply with a set of rather rigid requirements involved enormous expense, both direct and indirect.
>
> The Secretary of the Commission asked for a committee from the railroads to assist in compiling the proposed standards for new cars, and when this work was done the Commission had a hearing at which these proposed standards were submitted in the usual form with opportunity for argument.
>
> The railroads at once took the ground that the matter was not in shape for final determination; that, while they could comply with the requirements on new cars, the rigidity of the standards should be modified, variations allowed, and liberal time should be granted for changing the older cars. Discussion proved that the position of the railroads was correct and the hearing was adjourned to permit of a conference committee handling of the matter. This committee consisted of 15 members, five railroad mechanical men, five Interstate Commerce Commission inspectors and five labor-organization chiefs representing the locomotive engineers, firemen, conductors, trainmen and switchmen. The conference lasted several days with much argument and mutual concession, and settled the matter save two or three points on which no agreement could be reached. These and the agreed points, together with the respective arguments, were submitted to the Interstate Commerce Commission in a second hearing, and an order was issued under which the railroads are now working.
>
> The labor organizations were also not satisfied with the inspections of locomotive boilers as made by the railroads; at least they apparently could not understand why the engine crews were generally blamed in case of boiler explosions and they determined to have a Federal boiler-inspection law. Several bills were introduced in Congress, but by intelligent presentation, by the railways at the committee hearings, of information and records of the roads' methods of inspection and tests the more radical and unreasonable bills failed of passage. It was, however, recognized by the railroads that they could not consistently oppose reasonable regulation in the matter, and conferences were held with those interested to determine the essentials of a reasonable boiler-inspection

law. The American Railway Master Mechanics' Association had reported a set of minimum rules applying generally to all locomotives based on general practice. These were considered together with methods of administration, force, and the scope of their duties, etc., and the present law was framed to include these considerations and was not opposed by the railroads.

The law provided that the Interstate Commerce Commission should formulate and issue the rules under which the railways should inspect, test and report their boilers. The five railroad mechanical men who had conducted the Safety Appliance negotiations met with the boiler inspectors of the Commission and the labor organization representatives and agreed to the code of rules which, by order of the Commission, now regulates our boiler inspections.

Mr. Seley also relates, in his address, the almost inestimable benefits which have followed coöperation between the railroads of the country and the Post Office Department in drawing up specifications for construction and arrangement of postal cars. For instance, it is highly probable that only experienced technical men would have foreseen any great influence of these specifications on the safety of every railway passenger of a future generation. But it developed that a standard for postal cars, unless broadly considered and carefully drawn, might bar progress in the design and construction of passenger cars by its influence on expected legislation of the principle that the end construction should provide a yielding resistance to collision stresses, as by folding up, to harmlessly dissipate the energy involved and to prevent transmission of dangerous shocks back to the passengers. It is obviously better to have, in any regulating commission, inherent ability of making such technical studies than to rely on the more precarious chance of adequate consideration of such phases, as noted above, by consultation and in hearings. This ability can be secured in a commission or board in no other way than by having one or more engineer members.—ED.]

Borrow-Pit Practice on the Yuma Project, Lower Colorado, and Testimony in Favor of River-Side Pits

Sir—The writer has read with interest the communication from General Marshall in ENGINEERING NEWS. of Jan. 11, regarding "Borrow Pits for Levee Construction," and is surprised at the statement that the position of the borrow pits is determined by purely economic reasons. During the past few years he has designed and constructed some forty miles of levee along the Lower Colorado, and has also had excellent opportunity to observe the levee construction carried on by the California Development Co., and later, by Mr. Ockerson, in Lower California. The levee work under my charge was built in connection with the Yuma Project of the United States Reclamation Service, and in all cases the borrow pits were placed on the river side of the work; not for economic reasons, but because engineering considerations placed them there. In the writer's judgment, earth for levee construction should never be borrowed from the land side of the work. Such borrowing is justifiable only when necessary to defend the levee during floods when the river side is under water.

In defense of this opinion, reference is made to the accompanying cross-section showing the relative position of the river, levee and borrow pits. The elevation of the ground-water plane during low stage is also indicated. The rise of water against the levee is accompanied by a rise in the ground-water plane, and during full flood level in the river this ground water, in many cases, approaches the surface and sometimes reaches it. The result is a state of saturation of the earth adjoining the levee on the land side, which is decidedly dangerous to the stability of the structure, and it is sometimes necessary to reinforce the ground in such cases by weighting it with additional earth contained in an extension of the land slope of the embankment. It is clear from the accompanying cross-section that the ground on the land side of the levee is under considerable hydrostatic pressure during flood, and borrow pits situated on that side will decrease the power of the earth to resist such pressure. When saturation of the inner ground exists, the presence of borrow pits on that side has often been accompanied by boils in the bottom of the pits.

It was such a boil which destroyed the levee of the California Development Co. in Lower California in December, 1906. Although this work at that time had been constructed without due regard to the preparation of levee foundations, there was no reason for its failure with but 15 in. of water against it, except the presence of land-side borrow pits. In the levee afterward built by the California Development Co. the foundation was very carefully prepared, muck ditches provided, the slopes of the embankment blanketed with gravel, and every precaution taken, except in the position of the borrow pits, to make this levee probably as good as any ever built. In many cases the borrow pits were still located on the land side, notwithstanding such practice had resulted in the failure of the previous work. The levee built by the California Development Co. subsequent to December, 1906, has never had sufficient water against it to give it a fair test, so the behavior of this work has thrown no light whatever on the efficiency of either inside or outside borrow pits.

In a footnote appended to the communication from General Marshall, already referred to, you quote as follows from an article written by William Starling on the levees of the Mississippi, which appeared in ENGINEERING NEWS of Jan. 30, 1896:

> The material is taken from the front, or river side, if it be economically possible. The berm on the water side is usually 30 ft. The borrow pits must not be more than 3.5 ft. deep next the levee and 4.5 or 5 ft. next the river. If it be necessary to get material from the land side the pits must be distant 80 ft. or more from the inside slopestakes.

This article on levee work is one of the best I have read and shows clearly the necessity for river-side borrow pits. It is to be regretted that you did not quote from this article at greater length. With your permission, I will do so now:

> Very frequently, in high levees, the increase of strength is in the form of a banquette or "bench," placed on the land side.
>
> . . . . . .
>
> There is another reason for building banquettes to high levees in certain situations, and that is the weakness of the underground. No matter how good the material of the dike nor how much care has been exercised in its construction, if the natural soil on which it is placed be weak, the structure will be endangered. In fact, the foundation now becomes the weak point of the work. The levee itself, being composed of sound earth, well packed, is good and safe. The underground, however, is light and porous, traversed by roots and fibers and permeated by holes, and perhaps contains cavities. It is liable, therefore, to give way to the pressure of the external water; the more so if it be composed of fine and distinct particles, each of which becomes, as it were, enveloped by the water and is carried with it, the whole assuming a semifluid condition. How nearly both the levee and the external soil may approximate to this state is shown by the fact previously referred to, that in such situations a slight rod, like a cane fishing rod may often be thrust 10 or 12 ft., with little effort, into the earth.
>
> The effect of the external pressure, transmitted through or by such loose and weak stratum, may be to "blow up" the ground on the land side of the levee, or, roughly speaking, knock the bottom from under it.
>
> This is not a speculative or chimerical danger, but a very real one. The five breaks which occurred in the Lower Yazoo District of Mississippi, in 1890, are all supposed to have proceeded from this cause.
>
> . . . . . .
>
> Formerly banquettes were used only in exceptional situations, as at the crossings of deep sloughs or bayous, but they are now becoming general on all levees as much as 12 ft. high, or on sand or loam levees of much smaller size. The long slope given to the banquettes has been, of course, for the purpose of covering as much ground as possible.
>
> . . . . . .
>
> The measure of protection afforded by a levee to the lands behind it, though the embankment be sound and tight, is not complete; for the underground is still loose and porous, and transmits a

certain quantity of water, which may be exceedingly inconvenient, damaging and even dangerous. When the flow under the levee is diffused among a number of capillary tubes, it may be harmful to the adjacent lands, but it will not seriously threaten the existence of the levee, if the latter have sufficient base to keep it from "blowing up."

. . . . . .

As a result of these and perhaps of other causes, it is very common to find holes near the inner slope of the levee, which at flood time spout considerable volumes of water. These are regarded as dangerous or not, according to their size, their violence, the nature of the soil through which they pass, their condition, whether stationary or increasing in flow, the character of the water which they discharge, etc.

. . . . . .

Very often there occur violent outbreaks of water through the natural surface inside the levee, carrying with them large quantities of sand, which is distributed around the circumference of the hole exactly as ashes and cinders are deposited around the margin of a volcanic crater.

. . . . . .

The "sand-boils" previously alluded to are very common and very alarming incidents of every high water, and are especially prevalent since the great accessions which have been made in recent years to the height of the levees. . . . . They do not usually occur very near the base of the levee, but 40 or 50 or 100 or 200 ft. away; indeed, they are occassionally found 1000 ft. distant from the levee. In a given instance a large number of them occurred in a borrow pit, which had been dug (from necessity) on the land side of a levee, and threw out so much sand that they filled the pit in places to a depth of nearly 2 ft.

. . . . . .

When the boil is near the levee and of considerable dimensions it is unquestionably a symptom of danger.

. . . . . .

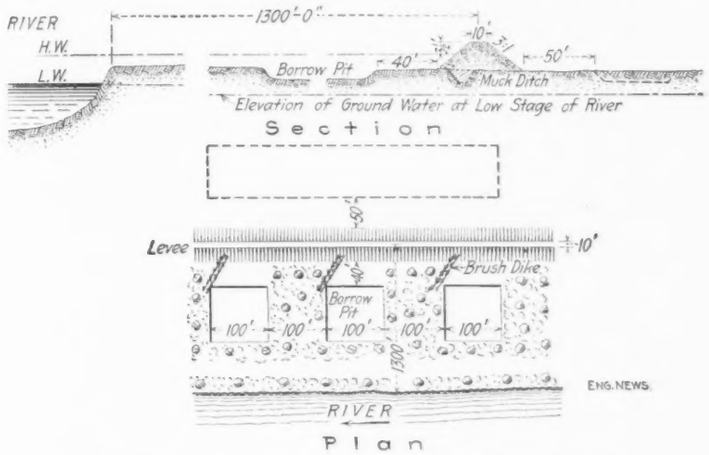
When the manifestation is formidable, as in the instance lately cited, the remedy that suggests itself and that is generally applied is to weigh down the weak place with an additional load of earth, which is usually laid upon a thick layer of brush, to allow a partial drainage of the leak water and to prevent the contamination of the new and dry earth by the mud of the old.

From the annual report of the Mississippi River Commission for 1891, I find, on page 3648, four recommendations as to future levee construction. The fourth recommendation is as follows:

The addition of a berm on the land side, where the material is porous, to give the necessary weight and stability to counteract the water pressure from the river side.

And on page 3649:

During high water it will be found that along the inside of the levee the ground is thoroughly saturated with sipe water, and as the roadway for travel is located here, each vehicle or animal passing only tends to make the ground more soft and boggy, so that in a short time the road is absolutely impassable for vehicles, and frequently for horsemen. To mitigate this evil, a drainage ditch is often cut to drain this water at a short distance from the base, which increases the danger of the water forcing itself through from the river side.



RELATIVE POSITION OF LEVEE, BORROW PITS AND RIVER

. . . . . .

The banquette affords additional section where most needed, and prevents dangerous leakage and sipage, as the additional distance the water has to percolate destroys to a great extent its power to transport material through the embankment. It affords a roadway at all seasons of the year without injury to the main levee, an important consideration during high water. The danger from insecure foundation or from levees built on porous soil is very much reduced, as the additional weight of the banquette on the inside of the levee prevents the water forcing its way up near the foot of the inside slope.

From the report of the Mississippi River Commission for 1897, page 4552, being a quotation from a letter by William Starling to the Commission:

Alarming symptoms of weakness have sometimes been revealed, however, in the natural soil under the levee. A striking example was afforded by the new work below Australia, which had been completed in 1895, but which had had no water against it until this year. Several large and threatening "boils," discharging considerable quantities of sand, broke out from 10 to 50 ft. from the base of the levee, on the land side, and continued to run turbid water for several days. From the same cause (insufficiency of base for so weak a subsoil) very extensive and dangerous sloughs or slips occurred in the same vicinity. This part of the levee had no banquette. It is about 12 ft. high. Where there was a banquette no trouble was experienced either with boils or sloughs. In places formerly distinguished by very large and ugly boils the difficulty has been entirely suppressed by the construction of banquettes. In my opinion, no large levee should be built without them, unless it is evident that both levee and underground will be composed of the strongest soil.

. . . . . .

Says General Comstock: "What is really needed for levees is that the surface of the ground water as one follows it from the river side of the levee, at the high-water level, through the levee and the subjacent ground to the ground-water surface at some distance from the levee on the land side, shall everywhere be below the surface of the levee and of the adjacent ground." The same opinion is held by many engineers. With a view to the determination of the hydraulic gradient of the ground water, some experiments were made this year, under my direction, by G. G. Smith. Four well points, with tubing attached, were driven back of the levee about 11 ft. high below Greenville, respectively, at the toe of the back slope and at distances of 50, 150 and 300 ft. from the toe. The ground water rose in the pipes, which thus performed the office of piezometers. The heights attained in the pipes and by the external water are shown in the accompanying plot, also the elevation of the natural surface. It will be seen that it would be difficult to build a levee which should satisfy General Comstock's requirements without inordinate expense.

Major Winslow says, in "No. 41, Occasional Papers Engineer School, U. S. A.," page 285:

The borrow pits are located when possible in enlargement and always in new work on the river side of the line, a wide berm being left between the borrow pit and the foot of the levee slope, while across the borrow pit traverses are usually left at intervals to prevent the pits at high water from becoming the channel of the stream and scouring out. In some cases, as when the original location of the levee was too close to the bank of a slough, it is impractical to get the earth for enlargement on the river side of the levee, and at times in banquette building, it would be too expensive to haul the earth for this over the levee from the river side. In such cases the borrow pit is located on the land side, but this is to be avoided when possible, as such pits are sources of weakness in floods.

. . . . . .

Regulations in the state of Mississippi respecting the construction and dimensions of levees show that the menace of the land-side borrow pit was appreciated by the early levee builders, for on page 166 of the Humphreys and Abbot report on the Mississippi River we read:

If from unavoidable causes it becomes necessary to procure material on the inside of the levee, it must not be taken within 60 ft. of the base. But it is not to be taken from the inside at all, unless forced by high water or some insuperable difficulty.

Additional authorities could be quoted on this matter, but the above appears sufficient to show that other than eco-

nomic questions govern the selection of borrow pits for levee construction.

It is clear from the above that in certain locations during high water the ground on the land-side of the levee may be in a saturated and unstable condition, and borrow pits located within this area would certainly be a menace to the safety of the levee. The engineer who so locates his borrow pits might be likened to a captain who scuttles his own ship.

Under the caption "How the United States Spent a Million Dollars in an ineffectual attempt to control the Lower Colorado," an article appeared in your publication of Dec. 7, 1911, by H. T. Cory, Member of the American Society of Civil Engineers. In this article, Mr. Cory objects to river-side borrow pits and his objection appears to be based solely upon the ground that they have a tendency to create erosive currents against the river slope. This, of course, is a serious menace to a levee constructed of light, friable soil, but such currents can be prevented and have been prevented by the methods adopted for levee construction on the Yuma Project, as shown by the accompanying illustration. The borrow pits on this work are not made continuous, nor separated only by short traverses, but what is known as the checkerboard system is employed. This consists of isolated pits, separated by at least equal areas of undisturbed ground, and supplemented by brush dikes connecting the levee top with the undisturbed brush. These works have been through several floods with water against the embankments for stretches of 10 to 15 miles, and no erosion of the levee has occurred. One short stretch of embankment was lost, due to caving banks, but the water did not even reach the base of the levee.

FRANCIS L. SELLEW.

Yuma, Ariz., Jan. 25, 1912.

Patents, and the Passyunk Ave. Bascule Bridge

Sir—In reference to the origin and use of forward bearings on bascule bridges, it will be interesting to trace the development of the idea, and show to what extent it is now used.

Great credit is due to the engineer of the Passyunk Ave. bascule, not only for this bridge, but for the many others of unusual merit built at Philadelphia under his direction. The Polk St. bridge in Chicago, and others, designed by a Chicago firm of engineers, are also among the finest bridges in that city.

Forward or face-wall bearings for movable bridges first came into general use on bascule bridges in the early part of the nineteenth century, when many double-leaf trunnion bridges were made with arch action when the bridge was closed. Several cast-iron bascules of this type were placed over the entrance to Hull Dock in 1815, some of which remained in use for forty-five years, and in 1860 there were no less than forty similar ones over the Forth and Clyde Canal. Later ones of this type are those over the Ouse River at Selby (1839), Wellesley Dock (about 1840), Stockholm (1851), and Commercial Dock, London (1853). The cast-iron bascule at Potsdam of 1830, with a clear span of 30 ft., had forward bearings with cantilever instead of arch action.

Many of the finest and most recent bascules in Europe have face-wall bearings, including those at Königsberg (1887), the Charlotte bridge over the Havel at Spandau (1887), one at Rendsburg over the Schleuse (1898); and indeed the same feature may be found on two of the very finest in Europe, the double bridge at Duisburg of 1906, and the Neva River bridge at St. Petersburg (1911).

Patents granted to E. S. Shaw of Boston, and to R. E. Newton of Milwaukee in 1904, showed bearings in advance of the trunnions, both trunnions and front bearings being supported on the projecting ends of cantilever girders. J. P. Cowing's patent of 1900 also had face-wall bearings in front of trunnions, for arch action in the bottom chord when the bridge was closed.

Face-wall bearings were also very generally and almost universally used during the first half of the nineteenth century, on double swivel plate-girder bridges, or those with two leaves meeting over the center of the water course, each leaf being mounted on a shore turntable. These bridges were so arranged that the lower chord acted as arch under live-load when the bridge was closed. One of the first users of the type was the celebrated Philadelphia engineer, William Strickland, who published an account of them in 1826. They were afterward much used: in Great Britain at St. Katharines Dock, London, in 1838; Plymouth, England, and Newry, Ireland, about 1840; Liverpool, 1857; and over the Great Lock at Havre, 1876, with its clear opening of 100 ft.

Similar face-wall bearings were generally used for single-leaf plate-girder swings, instances being those at Duffel, 1844; over Berlin-Spandau Canal at Berlin in 1860; at Havre and Fecamp, 1870. Other somewhat similar ones on the Schwedler system crossed the Peene at Anclam, 1871, and the Spoy Canal at Cleve, any of which might be prototypes for the long-span railroad girder swing over the Chicago River near Clybourne Place, finished in 1899.

A number of important European truss swings, containing the feature of front-wall bearings under live-loads, include the double bob-tail bridge at Buccleugh Dock (1880), the double swing at Tarente (1887), with a clear channel of 188 ft.—the largest in Italy—the Neuhof swing of 1900 over the Elbe delta, with a total length of 246 ft., and the new double swing at Lubeck of 1901, somewhat similar to that at Tarente, with a clear opening of 50 m.

It is now well known by bridge engineers that many if not most of the drawbridge patents of the last twenty years are merely revivals of designs worked out many years ago by others. It is to such men as Delille, Belidor, Ardagh, Bergeré, Derché and Poncelet that we are indebted for many of our best drawbridge inventions, most of them being quite fully developed and described in the twenty years following 1820. A patent on hinged counterweights was granted in 1876 to Samuel Swartz, of Buffalo, and the same device was used in 1878 on the old Langebro bascule in Copenhagen. Compensating counterweights, revived in America during the last quarter century, were successfully used by Col. Ericsson in 1851 on a double bascule bridge over the lock at Stockholm. Many other features of modern bridges, generally supposed to be new, were carefully planned and executed long before the present generation was making bridges of any kind.

In reference to the solid floor on the Passyunk Ave. bridge, somewhat similar ones were used on the bascule leaves for the Tower Bridge at London, the Duisburg bascule, another at Königsberg, and at Portsmouth, England. The most familiar case is that used by Sir John Wolfe Barry on the Tower Bridge, where the buckle plates are covered with two layers of plank, and overlaid with wood blocks. In designing the Portsmouth bascule, J. J. Webster used a stamped-steel plate, with cross timbers at intervals between the blocks to hold them in position. The bascule at Königsberg on the site of the old Kottell bridge also has a trough floor.

It should again be stated that the present generation of engineers is fortunate in having such a complete and carefully worked-out bascule design as the Passyunk Ave. bridge given freely to the public, when it would seem that some of its parts were as much entitled to patent protection as many other bascule features which have been similarly covered.

H. G. TYRRELL.

540 Judson Ave.,

Evanston, Ill., Jan. 26, 1912.

Notes and Queries

The Key West Extension of the Florida East Coast Ry. was opened on Jan. 22 of this year, instead of June 22, as a typographical error made the note read on p. 183 of our issue of Jan. 25.

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Engineering News

Private Water Rates Controversies in Pennsylvania

Much commotion among water users in an eastern district of Pennsylvania was caused not long ago by a material increase in the water rate charged by a parent and subsidiary companies supplying a number of townships and municipalities. The case, we believe, went into the courts and is there still. Now come reports of the raising of rates by the Pennsylvania Water Co., which supplies Wilkinsburg, Swissdale, Edgewood and other towns in the Pittsburg district. The Wilkinsburg *News*, of Jan. 19, in an editorial entitled "Too Much Greed May Be Fatal," suggests that the raising of water rates by private water companies is likely to lead to municipal ownership or to rival companies. It seems pertinent to inquire why the water consumers in both the western and eastern districts of the state, who have made so much objection to the raising of rates, do not unite in demanding a public-service commission to control rates and to settle all sorts of controversies which are continually arising between public-service companies and their patrons. More than half the states in the Union, we understand, now have public-service commissions.

Refuse Incineration and Engineering Problems

American cities generally have been very dull and slow in realizing that refuse disposal is an engineering problem. As proof of this assertion, witness the scores of dilapidated and uneconomical garbage furnaces scattered over the United States. Now and then some city, more progressive than the mass, awakes to a thorough realization of the nature of the refuse-disposal problem and calls in a competent engineer to guide in its solution. More often some alderman or mayor tackles the problem with unlimited confidence in his own knowledge and ability. Such a state of affairs appears to exist at Pasadena, Calif., where it is reported that William Thum, mayor of that city, is attempting to formulate general specifications for a refuse incinerator, which, it is said, must be in operation as early as Aug. 14 of the present year. If Mayor Thum is correctly represented, he thinks he can satisfactorily solve the local refuse-disposal problem by getting the builders of incinerators to assist him in the preparation of general specifications and then throwing the contracts open to competitive bidding, apparently without bothering to consult a competent engineer in behalf of the city. We hope the information we have is misleading and that it is no part of Mayor Thum's plan to do without the guidance of an engineer. We are not objecting to the formulation of general specifications and the invitation of all reputable contractors to bid upon them. If, however, this course is pursued, there is all the greater need for having the guidance of the most competent engineer available, both in the formulation of the general specifications and in passing upon the contract bids and plans when these are received, as well as in taking charge of the tests which must or should be made on the completion of the incinerating plant and before its acceptance by the city. The shortness of the time available, if a plant is to be in operation by Aug. 14, makes it all the more imperative to secure the services of a first-class engineer to represent the city in this undertaking.

Gas Combustion at Hot Surfaces

Since Prof. W. A. Bone, of Leeds, England, described before the American Chemical Society and American Gas Institute work which was being done on the other side of the Atlantic in the flameless combustion of gaseous fuel (as noted in our issue of Jan. 18) it has been brought to our notice that a similar scheme was developed, by Prof. C. E. Lucke, of New York City, and patented by him in 1901 and 1902.

Prof. Bone's work, however, seems to have resulted in some commercial applications, while so far as we are aware, nothing has been done toward the exploitation of Prof. Lucke's scheme during the ten years since the patents were issued.

If this is correct, it is merely another illustration of the great difficulty which American inventors find in having their ideas taken up commercially—a situation which we have commented on before.

The ready hearing which has been given to Prof. Bone's claims and the slowness to recognize the similarity of his results with those secured by Prof. Lucke have surprised many who have remembered the latter's work. The difference, however, is partially explained by the quite different roads by which these two investigators proceeded to the development of essentially the same type of apparatus. Dr. Lucke set out to find some way of preventing the "backfiring" and "blowing out" of flame in a column of combustible gaseous mixture. He recognized the need of localizing the contact

surface between flame and combustible mixture and proposed to do this through keeping the velocity of propagation equal to the velocity with which the gaseous mixture was fed. Experiment showed him that this was secured in a very practical way by burning the explosive mixture in a pile of loose fragments of refractory materials; the increased velocity through the first interstices was sufficient to prevent backfiring and the spreading paths automatically reduced the velocity until the actual combustion surface was a hemisphere. Increase or decrease of initial pressure and velocity was automatically compensated for the enlargement or contraction of the hemispherical area.

We judge from Prof. Bone's paper that he started off with common knowledge that porous bodies materially accelerated chemical combination of gaseous mixtures and that this property greatly increased with increasing temperatures. The familiar example of the ignition of gases and vapors by a piece of spongy platinum illustrates his starting point. His search was for refractory materials which would stand the high temperature and for arrangements which would accelerate combustion and secure temperatures not possible with simple flame processes. He evidently was looking toward intensified operation, while Prof. Lucke sought automatic regulation.

One difference between the work of the two investigators may have some bearing on the more direct application of Prof. Bone's work to commercial use. Prof. Bone seeks to increase the heat transmitted by a given heating surface by carrying on the combustion process in close contact with it. Prof. Lucke buries his combustion surfaces in a coned pile and applies the gaseous products of combustion alone to the work of heating.

The British Government's Purchase of the Telephone Business

On the last day of 1911, the plant, land, buildings and other property of the National Telephone Co., of Great Britain, were transferred to the British government and will be operated as part of the Post Office system. This was a final step by which the government has taken over the operation of the entire telephone service of the United Kingdom, with the sole exception of the cities of Portsmouth and Hull, where the telephone business is carried on by the city government. In our issue of Feb. 23, 1911, we recorded the general conditions under which the government purchase of the company's plant was made. It now appears from an article in the London *Electrician*, of Jan. 5, that several problems have come up not touched by the agreement already noted. For instance, no provision was made in the government purchase for taking over the staff of the company. Naturally, the employees of the company were much dissatisfied and by direct representation to the Postmaster General and to members of Parliament, a promise was obtained that all of the staff who had had at least two years' service would be offered positions under the Post Office management. Later, an additional promise was secured that members of less than two years' service would be taken over. The men at the head of the company were not included in this arrangement, however, and the engineer-in-chief and his assistants, the general superintendent and the superintendents for the London, Midland, Northwestern, Northern Scotland and Southern divisions have been dropped in the transfer.

The purchase agreement made no provision for new work, so that the company lost all money expended on plant not earning revenue before the transfer. The result was that the company for a long time previous to the transfer had reduced its expenses and all construction work to a minimum and placed the cost of much replacement work in current expenses, which were rather increased than otherwise. Reduction of new work also resulted in the discharge of a number of the old construction staff.

The telephone company had paid great attention to the technical education of its staff; evening classes and correspondence courses had been arranged at slight expense to employees; societies had been encouraged for the discussion of telephone-engineering questions and premiums had been paid for the best papers read; an educational committee had also received suggestions for the improvement of the service and gave rewards for those used; the company had also published its own paper, *The National Telephone Journal*. There is no appearance of maintaining these activities under the government service.

The price to be paid to the company by the Post Office cannot yet be fixed. The plant and buildings were to be sold at "present value," and this may require valuation by an official commission.

In 1911, $1,768,000 were collected by the government in stamp taxes on telephone messages. The question arises whether the government will be able to retain that revenue, or will remit it to the subscribers. There is some belief that it will be needed to meet expenses. The telegraph service is now run by the Post Office Department at a loss; hence when one sends a telegram in England the British taxpayers stand part of the cost, while the person who sends a message by telephone pays a tax in addition to the reasonable cost of service.

Because of the small amount of construction work done by the company during the past year, the Post Office finds itself in charge of a plant which requires a large amount of construction to be done at once; but for which no intelligent plans have been made.

The whole situation is being closely followed by the various British public-utility corporations, nearly all of whom operate under limited franchises, and must look forward to having their plants eventually taken over by the cities or the national government.

There can be no question that the government has an opportunity to greatly improve the telephone service in Great Britain and to greatly extend the scope of its operations. There are more telephones in New York City alone than in the whole United Kingdom of Great Britain and Ireland. The service is also much inferior to the service generally given in the United States.

It should in fairness be said, however, that the backward state of telephone development in Great Britain has been due partially to the division of the business in the past between the National company, the cities and the Post Office.

Experience here, as well as in England, has conclusively demonstrated that the telephone business is no place for competition; but ought, in the public interest, to be carried on as a monopoly.

Meanwhile, the present experience in Great Britain is instructive as to the measures that should be taken when a public utility operates under a limited franchise to secure good service and prevent deterioration and disorganization as the franchise draws near its end.

A National Commission to Promote Safe Railway Operation

"The time has come in this country to inaugurate a system of supervision over interstate railways somewhat similar in character to that now administered in England by the British Board of Trade."

The above quoted recommendation is not made by demagogues or by politicians seeking to make votes by attacking the railways. It is the opinion of a Board, made up of high-class engineers, which has been for four years studying the question of safety in railway operations. The chairman of this Board is Prof. M. E. Cooley, Dean of the Engineering School of the University of Michigan. The other members of the Board are Azel Ames, formerly Signal Engineer of the Lake Shore & Michigan Southern R.R.; F. G. Ewald, Consulting Engineer of the Illinois Railroad Commission, and B. B Adams, for a score of years Editor of the *Railroad Gazette*. These men speak with the authority of experts and their recommendations deserve consideration, not only by Congress, to which this recommendation is made, but by railway officers and by engineers.

Space does not permit us to reprint in full the report just issued by this Board (which is known as the Block Signal and Train Control Board), but we can testify that it is a masterly discussion of the matter of railway safety, and deserves the careful study of responsible railway officers. We fail to see how any railway officer who reads the report with a mind reasonably free from prejudice can oppose the wise measure for government supervision to secure safety in railway operations which it recommends. Does anyone deny that there is need of systematic work to reduce railway dangers? A brief study of accident statistics completely dispels such a notion.

Notwithstanding all that has been done in the introduction of safety devices in railway operation during the past quarter century, there is no material diminution in the annual totals of railway casualties. The work done in the introduction of safety appliances no more than keeps pace with the increased danger due to greater density of traffic, to increased train speed and to increasing difficulties in securing efficient and reliable employees.

The great defect in the work which has been done in the past to promote railway safety has been that it has been piecemeal, haphazard, unsystematic. A good example is the National Locomotive Boiler Inspection law, enacted a year ago. This law was passed, it is well known, in response to the demands of the labor unions, but it would be easy to point out directions where the same amount of money expended by the government to promote railway safety would yield far larger returns in saving lives and limbs.

It may be claimed that the majority of railway companies are now operated with reasonable safety, and that Federal supervision over them is unnecessary. This, however, is really an argument in favor of legislation, for the safety of passengers and employees on the best managed roads is jeopardized by the slovenly practice of the worst managed. The freight cars owned by one railway travel all over the country. Engine runners who are allowed to form careless habits or work under unwise rules, may be later employed upon another road having entirely different rules.

It is true that the well managed railways try to bring pressure upon their backward brethren through such organizations as the American Railway Association, the Master Car Builders Association, and others. But the work done by such organizations is restricted and limited compared with what ought to be done to put American railroading on a safe basis.

Even from the narrow point of view of net earnings, railway companies need to bestir themselves to raise their standard of safety. There is no doubt that legislation is to be enacted which will establish compulsory compensation for all employees who suffer injury or death in the course of their work. The old defenses of the employer in a damage suit, of contributory negligence and of negligent fellow-servants, are to be swept away. Accidents and minor casualties to employees in the railway service are going to be very much more expensive in the future than in the past. The railways cannot, by any means afford, therefore, to neglect measures which will increase the safety of operation.

It is for this reason, among others, that the recommendation of the Block Signal and Train Control Board is actually in the interest of the railway companies as well as the public. The railways will serve their own interests, as well as the public's interest, by using all their influence in its favor.

It should be understood, of course, that in recommending the creation of such a Railway Safety Commission, it is assumed that it would be made up of high-class experts, competent to take a broad view of their field of work and with the technical knowledge and good judgment necessary to make their advice, recommendations and orders carry weight with the railway administration.

One fault of the piecemeal work for railway safety promotion which has been hitherto done under the Interstate Commerce Commission is that it has been of too small caliber, to put it plainly. Government supervision over railway operations will not have beneficial results unless the supervision is put in charge of men who will command the respect of railway officers. Neither political appointees, mere clerks, nor men who know railway operations from the limited viewpoint of a railway employee alone, can fill the requirements.

The whole situation summed up in a word is another example of the frequent case where the public stands in need of the services of high-class engineers and can obtain great benefit from such services whenever it is wise enough to avail itself of them and to pay the price necessary to secure them.

The First Shield-Driven Tunnel in America: Early History of New York Subways

The excavation of that section of Broadway opposite City Hall Park, New York City, to build Section 2 of the new Lexington Ave. subway will bring to light one of the earliest schemes for rapid transit in New York City or elsewhere. This was an underground railway line originally chartered in 1868 as the Beach Pneumatic Transit Co., for the transportation of letters, packages and merchandise by means of pneumatic tubes less than 54 in. in diameter, under patents granted to Alfred Beach, Editor of the *Scientific American*, in 1867.

Out of this grew a scheme for transporting passengers in cars to be driven in 8-ft. tubes by air pressure, and about 200 ft. of subway was actually built under Broadway from Warren St. to the southerly side of Murray St. in 1870. The tube was circular, brick-lined, and 8 ft. in the clear. It was built by driving forward a shield by hydraulic jacks, and all the work was done without disturbing street traffic, so quietly that apparently few people either knew or suspected of its existence.

The shield invented and used by Mr. Beach in driving this tunnel was the third device of its kind to be actually used in tunnel construction, and the first to be used in America. It was antedated only by the first Thames tunnel shield of Brunel and the London Tower tunnel shield of Barlow and Greathead in England.*

In 1873 the franchise of the company was further extended to permit it to construct and operate an underground steam railway for both passengers and freight. The project seems to have hung fire for a number of years, but we read in ENGINEERING NEWS of Nov. 6, 1880, that "the road is quite likely to be built within the following three years." At this period the project was in the hands of the New York Underground Ry. Co., of which Gen. George B. McClellan, of Civil War fame, was President, and Walter J. Morris was Chief Engineer.

The railway was to have been built underground from South Ferry, at the southern end of Manhattan Island, by way of Broadway, under Union and Madison Squares to about 100th St., where it was to become an elevated structure as far as the Harlem River. It was to have been constructed as two parallel tunnels below the center of the street, low enough to avoid gas and water mains, and the sewers were to be diverted to the two sides.

The method of construction proposed was to build in short sections a temporary wooden floor of heavy timbers to carry the street, the work to be carried out at night so as to avoid interrupting traffic. As fast as a section was completed the street was to be restored and repaved at the expense of the company.

The cars, stations and tunnels were to be lighted by electricity, but for moving the trains 60-ton steam locomotives were to be employed. According to the promoters of the project these locomotives were "to consume their own smoke and

*See Engineering News, Jan. 30, 1902.

condense their own steam, thus insuring, with the aid of air shafts at intervals, a healthful atmosphere within the tunnels."

The scheme continued to be heard from at intervals for a number of years more, and in 1883 the charter of the company was further modified to permit the building and operation of a 4-track subway "arcade," with sidewalks along the entire route. The two middle tracks were to be used for express trains and the outside tracks for local trains stopping at frequent intervals to take on and leave passengers like the surface street cars. Stores and business places along the route were expected to have basement entrances and arcades. In the same year the company is stated to have filed a bond of $100,000 with the controller of the city as a guarantee for the completion of the road by 1886. History does not state what became of that $100,000.

No sooner had his scheme died than another appeared to take its place under the name of the New York District Railway Co., which in 1886 made elaborate plans to build a 4-track subway for electrically operated trains*. These plans, in general detail and method of construction, approached quite closely to those ultimately carried out a number of years later, when the present subway system was built, although the early conception of stations and cars does not appear to have been realized. William Barclay Parsons was Chief Engineer of this project, which was finally abandoned because of the fears of abutting property owners for the safety of their buildings during the construction work.

When the Rapid Transit Commission came into existence in the early '90's the scheme for constructing a tunnel under lower Broadway without disturbing the street surface was revived and was advocated by John Bogart and the late W. E. Worthen, engineers of the Rapid Transit Commission†. Strangely enough, these reports make little or no reference to the earliest scheme.

The contract for this section of the new subway has been let to the Degnon Contracting Co., and this company's engineers are looking forward with interest to the uncovering of the first rapid transit subway in America.

Why Pavements Deteriorate—It is a well-known fact that a new pavement is no sooner down than gangs of men appear to dig trenches in it, the need for which, it often seems, might have been anticipated and met before the pavement was laid. The Chicago Record-Herald uses this as a basis for a squib which will be appreciated by many of our readers:

Contractor: I wish to get a permit to dig up the pavement on Main St.

Why, we can't give you that. There isn't any pavement in Main St.

I know; but I want the permit so that we can dig up the pavement as soon as there is one.

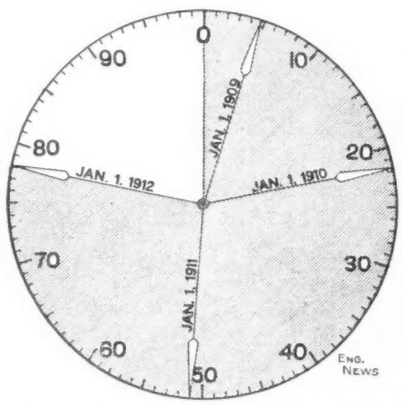
*Engineering News, Jan. 2, 1886.

†See Engineering News, Oct. 17, 1891.

Progress on the Catskill Water Supply

As has been frequently pointed out in the columns of ENGINEERING NEWS, the work on the Catskill water-supply project is being pushed with all possible haste in order to secure the delivery of water from Esopus Creek into the Croton reservoir. While this will still leave New York City dependent on the old Croton aqueducts, which are at present being used nearly to their limit of capacity, it will put an end to the danger which has been hanging over the city for years of a water famine occurring through the exhaustion of the supplies stored in the Croton watershed.

In order to accomplish this end, the construction has been largely concentrated on the upper divisions of the work. The accompanying diagram shows graphically the progress which has been made up to Jan. 1, 1912, on the works



PROGRESS OF COMPLETED CONSTRUCTION ON THE CATSKILL WATER SUPPLY SYSTEM NECESSARY FOR THE DELIVERY OF CATSKILL WATER INTO CROTON LAKE

whose completion is necessary for the delivery of the Catskill water into Croton Lake. The remarkable progress made during the past two years is an especially noteworthy feature of the diagram. It will be understood that the works covered by this diagram are only those which are absolutely essential to the delivery of the water. Many auxiliary works will still have to be completed on the upper divisions, such as the removal of the Ulster & Delaware Ry. line from its present location in the bed of the reservoir. On the lower sections a very large amount of work remains to be done, including the great Kensico reservoir and the network of deep pressure tunnels underneath Greater New York by which the water is to be distributed.

County Health Officers of some description exist in 18 of the 48 states of the Union, according to a table published in "The American Year Book" for 1911. In many cases they are appointed rather than elected.

Reconstruction of the Sibley Bridge over the Missouri River, A. T.&. S. F. Ry.

An interesting work in bridge reconstruction, made necessary by the increased weight of modern locomotives and equipment, is the rebuilding of the bridge which carries the Atchison, Topeka & Santa Fe Ry. over the Missouri River at Sibley, Mo. The bridge was built in 1887 for the Kansas City and Chicago extension of this railway, and was designed for a moving load of two 86-ton consolidation (2-8-0) engines followed by a train load of 3000 lb. per lin.ft. The foundations and substructure were built by Sooysmith & Co., and the superstructure by the Edge Moor Iron Co. The late Octave Chanute was consulting engineer.

The bridge is composed of the following spans, beginning at the west end: 80-ft. deck girder, 200-ft. deck truss, three 396-ft. through truss spans, 247-ft. deck truss, two 172½-ft. deck trusses, and about 2000 ft. of steel-girder viaduct consisting of 30-ft. towers and 60-ft. spans. The three long truss spans are of the Whipple type; all the others are of the Pratt type. The piers are of stone masonry, and those in the main channel of the river are founded on bed rock. Five of the piers were built by the pneumatic caisson system.

The reconstruction work is as follows: (1) remodel the west abutment and pier No. 1, and erect a new 80-ft. deck-girder span; (2) replace the 200-ft. truss span with two 100-ft. girder spans, and build a new intermediate pier for these; (3) erect three new truss spans of 396 ft. each, and replace 8 to 20 ft. of the old masonry tops of the piers with concrete, owing to the disintegration of the stone; (4) erect three new deck-truss spans at the east end, and remodel the masonry of the piers to fit the new spans; (5) rebuild the substructure and superstructure of the east approach viaduct.

The new structure is designed for Cooper's E-60 loading; two 135-ton 2-8-0 engines (with 60,000-lb. axle loads) followed by 6000 lb. per lin.ft. The entire structure will have a ballast deck, with footwalk and hand-railing on one side. Steel brackets are provided on the downstream side for carrying all the telegraph, signal and telephone wires. While the bridge is being rebuilt as a single-track structure, it will be laid with gantlet tracks, the two rails of each pair being spaced 7 in. c. to c.

The piers for the east-approach viaduct will be of concrete, with foundations of reinforced-concrete piles, the tops of which will be about 12 ft. above the extreme low-water line. The track across this viaduct now has an ascending grade of 0.8% against westbound traffic. It is extended to raise the eleva-

tion at the east end sufficiently to reduce the grade to 0.5%. An interesting feature in the viaduct is that an expansion bearing is being put on one bent in each tower. This bearing is made up of four 12-in. segmental rockers. In designing this viaduct it was necessary to take span lengths such that all the new piers would alternate with the old ones. The masonry in these old piers is very badly shattered and worn, partly because of faulty design of the bottom of the metal columns and partly because the piers are not supported by foundation piles.

Work is now in active progress for replacing the 396-ft. spans. Over half of the material for these spans is already at the bridge site, and it is expected to begin the erection of the west span early in February. The American Bridge Co. is furnishing the steel superstructure for the entire bridge. The Missouri Valley Bridge & Iron Co. has the contract for remodeling the four large piers, for building falsework, taking down the old spans and erecting the three new ones. A contract will be let for the substructure required in the approaches, but the erection of the metal work in these approaches will be done by company forces.

In rebuilding the main spans, the elevation of base of rail will not be changed, but the clearance line above the water will be 2 ft. lower than its present position. Permission for doing this has been obtained from the government, through a bill which has just passed the two houses of Congress and has been approved by the President. With this lowering of the clearance line, the bridge will give a clear headway of 48 ft. above the extreme high-water line of 1844. But the headway will be greater than this when taken from the standard high-water line which has been adopted by the War Department.

With reference to the handling of traffic during the erection of the long spans, the falsework is being built heavy enough to carry the new steel and also to provide for traffic. All the plans and operations for work on the entire bridge will be based on handling traffic during the work. However, when changing the floor of the long spans (that is, taking out the floor beams and stringers and putting in the new ones), one or two trains each day may be detoured over the Wabash Ry. into Kansas City. But all other operations will be handled between trains. For about two miles east of the bridge, the 0.8% grade will be reduced to 0.5%. The substructure for the east-approach viaduct will be built, and then the old superstructure jacked up to meet the new grade. Then when the superstructure of the new viaduct is built the track will be at its permanent elevation. It is expected to handle all operations so that there will be no material delay to traffic.

The cost of reconstruction will be about $1,200,000. It is hoped to finish the bridge by the end of 1912, although this may be prevented on account of high water, ice, etc. For information as to the above work we are indebted to A. F. Robinson, bridge engineer of the A., T. & S. F. Ry. System.

A Premature Blast of Dynamite on the Canadian Northern Ry., near Fort Francis, Ont., Feb. 9, killed 12 workmen and injured five others. The men were buried, while at work in a cut, by material brought down by the blast.

Wholesale Asphyxiation from Illuminating gas in Philadelphia, Feb. 6 and 7, was averted, according to press reports, only by the activity of the police in arousing the occupants of dwellings in the affected districts. On Feb. 6, five persons were killed and 20 others temporarily overcome by gas which reports state had entered through sewer connections after having escaped from the gas mains. The heavy leakage from the gas mains was ascribed by an official of the United Gas Improvement Co. to the cold weather. The entire block bounded by Callowhill, Carlton, 22d and 23d Sts. was affected. On Feb. 7, escaping gas from a leak in the pipe leading from the gas main to two houses in McKean St., near Sixth, overcame the 25 occupants at an early hour in the morning. Persons outside the house detected the leak and rescued the victims in time to save their lives.

Statistics of Accidents to American vessels at sea during the fiscal year 1911 are given in a bulletin issued by the U. S. Bureau of Navigation. The number of lives lost on American vessels totaled 196. The loss of sailing vessels, principally by foundering, caused the death of 107 persons, while 89 lives were lost with steam vessels. Of the 325 vessels wrecked, 159 were steamships. The principal disaster during the year was the loss of the steamer "Arkadia," which sailed from New Orleans for Porto Rico with 37 people on board and never was heard from. Another serious disaster was the sinking of the Pere Marquette R.R. car ferry No. 18, in Lake Michigan, with the loss of 27 lives.

Boiler, Elevator and Flywheel Accidents in the United States and Canada caused a total of 35 deaths during the month of November, 1911, according to lists compiled by the Fidelity & Casualty Co., of New York. This is five less than the corresponding figure for October.

Boiler explosions listed in November numbered 27 and caused nine deaths. Both figures are less than for the previous month, when there were 35 explosions and 15 persons killed; but the figures for October are higher than for any month from April to September inclusive.

The number of elevator accidents in November was 85, as compared with 92 in October; but 25 persons were killed, as against only 22 in October. Of the 25 killed in November, seven fell down shafts, 16 were crushed or struck by elevators and two were killed by the fall of an elevator car.

Only one flywheel explosion is listed for November. This was at the plant of the American Steel & Wire Co., at Newberg, Ohio. One person was killed and three others were injured. In October there were eight flywheel accidents, including three grinding-wheel explosions, and the total number of persons killed was three.

Statistics of Railway Accidents on all the lines operating in New York City during the year 1911 have been given out by the New York Public Service Commission. The total number of persons killed is given as 3144, of whom 16 are classed as suicides. The number of persons injured was 39,386, of whom 26,030 were passengers. Of the persons injured 17,827 were hurt in getting on or off cars. The number of car collisions was 1436.

Acetylene Caused No Deaths nor material fire losses in the United States during the months of August, September and October, 1911, according to a report published in the January "Acetylene Journal," the official organ of the International Acetylene Association. A record has been kept by the "Journal" of accidents caused by petroleum, city gas, electricity and acetylene as reported in the daily press of the country. The record of deaths from these causes is summarized as follows:

	Aug.	Sept.	Oct.
By petroleum.....	81	73	51
By city gas.....	26	36	58
By electricity.....	36	34	31
By acetylene.....	none	none	none

Fire losses in the same three months from these three causes totaled $880,500, and were divided as follows:

	Aug.	Sept.	Oct.
By petroleum..	$94,100	$117,600	$198,800
By city gas....	25,000	5,000	48,000
By electricity..	40,000	323,000	23,000
By acetylene...	6,000	none	none

To emphasize the importance of this favorable showing, the "Journal" states that acetylene is now used in this country by upwards of two millions of Americans, with many of the number rather unfamiliar with gaseous illuminants. The increased safety of acetylene generating plants is ascribed in large part to the efforts of the engineers of the National Board of Fire Underwriters.

Twelve 146,000-volt Transformers are being built by the General Electric Co., of Schenectady, N. Y., for the Eastern Michigan Power Co. These are for 60-cycle operation and each has a capacity of 3000 kv.-a. They will stand about 19 ft. high on a floor space 11x5 ft. Each transformer will contain about 4000 gal. of oil, and oil-filled high-tension leads will be used, each lead itself containing about 30 gal. of oil. These terminal casings have cast-iron bases which are fitted to the cover and extend down into the tank well under the oil. Each terminal is tipped with a brass ball and the whole lead is designed to reduce the possibility of corona discharge. The transformers are designed to withstand a test of 280,000 volts between the high-tension winding and all other parts. These are the highest voltage transformers yet developed for commercial service. Some two years ago the Stanislaus (Calif.) Power Co. was supplied with seven transformers designed for commercial operation on a line of 138,500 volts.

Comparative Tests of Locomotive Boilers, one equipped with a firebox of the standard stay-bolt type and the other with a Jacobs-Shupert sectional firebox, are to be carried out, at Coatesville, Penn., from February to April of the present year. These tests are to be under the direction of Dr. W. F. M. Goss, Dean of the College of Engineering of the University of Illinois, for the Jacobs-Shupert U. S. Firebox Co., of Coatesville. The two boilers to be tested are as nearly

identical as possible and have the following dimensions:

	Jacobs-Shupert firebox	Stay-bolt firebox
Outside diameter of shell of boiler at front end	70 in.	70 in.
Diameter of throat of boiler	83 7/8 in.	83 7/8 in.
Number of tubes	290	290
Length of tubes	218 in.	218 in.
Diameter of tubes	2 1/4 in.	2 1/4 in.
Inside length of firebox	109 5/8 in.	109 11/16 in.
Inside width of firebox	76 3/8 in.	76 1/4 in.
Height of top of crown of firebox above bottom of mud ring	73 1/16 in.	74 13/16 in.
Number of sections composing firebox	11	....
Diameter of radial stays	....	1 in.

There will be three series of tests, beginning on Feb. 1; the first is to determine the relative amounts of heat absorbed by the two fireboxes under similar conditions of operation; the second is to establish the evaporative efficiency and capacity of the two boilers, and in addition to the data determined in ordinary boiler testing an attempt will be made to secure some information concerning conditions which affect the circulation in the two cases; the third series of tests is arranged to try the strengths under low-water conditions.

For the last series the boilers will be removed to a location where their explosions would not harm surrounding property or endanger the safety of the observers. These tests will be carried on progressively, beginning Apr. 1, until destruction or serious deformation of the firebox occurs. At regular stages of the tests examinations will be made of all parts, and if minor defects appear, such as leaky stay-bolts, they will, so far as possible, be corrected before proceeding with the next step in the test.

The Jacobs-Shubert firebox was fully described in Engineering News of June 17, 1909. The Coatesville tests will be along similar lines, but more comprehensive than those conducted by the Atchison, Topeka & Santa Fé Ry., in September, 1910, and described in Engineering News of Nov. 3, 1910.

A Notable Outbreak of Typhoid Fever in portions of New York City, amounting to 380 cases more than the normal for the district concerned, has been attributed to milk infection from a typhoid carrier of 46 years' standing. The outbreak occurred in 1909, but has just been reported by Charles Bolduan and W. Carey Noble, of the Department of Health, New York City, in the Journal of the American Medical Association for Jan. 6, 1912, and in reprints from that source which are being distributed by the Department. Significant features of this outbreak were: (1) the fact that the milk involved was shipped only occasionally to New York; (2) that it appears to have been a constant source of infection in the village of Camden, N. Y., for years past; (3) that the milk producer (who was the typhoid carrier) was particularly cleanly, both personally and as a dairyman.

The Movement for Municipal Ownership of water-works at Omaha, Neb., continues to be retarded by litigation. A court decision makes it imperative for the city to take the works at the appraised value ($6,263,295). Last summer the people voted $8,250,000 in bonds to pay for the plant and for extensions. The validity of the proposed bond issue is being contested in a taxpayer's suit, which is likely to delay the completion of the purchase for some months to come.

Water and Sewage Treatment at Chicago has been accepted by the Sanitary District of Chicago as a necessary feature in the water supply and sewage disposal systems. Preliminary steps have been taken toward carrying out the program outlined in a report made on Oct. 12, 1911, by Mr. George M. Wisner, Chief Engineer (Eng. News, Nov. 30, 1911). No definite action has been taken as yet, however, in regard to the preparation of plans or commencing construction. On Jan. 4, the Board adopted a resolution directing the chief engineer to prepare plans and specifications for a sterilization plant for treating with hypochlorite of lime the water supply taken from the 68th St. crib, but the resolutions were tabled to await the report of the attorney as to whether the Board has the authority to undertake this, and also to await prospective action in the matter by the city of Chicago. The Board is negotiating with a committee of the packing companies toward carrying out a plan of reconstruction at the stockyards and establishing an experimental sedimentation plant. Resolutions have been adopted, also, looking toward the investigation of the sewerage and water supply conditions of these municipalities lying north of Chicago which discharge their drainage and sewage into Lake Michigan. It is proposed that as soon as these municipalities provide a system for intercepting and gathering all this drainage and sewage, the Sanitary District will provide the necessary channels and other works for diverting this into the new North Shore Channel, forming a part of the Drainage Canal system. Still another resolution that has been passed advises that all sewer outlets built in the future in Chicago should be provided with settling basins, so as to prevent the discharge of solid matter into the river and the drainage canal.

Portland Cement Production in 1911—Complete statistics for the year 1911 were received by the U. S. Geological Survey during the month of January from about 70% of the portland cement manufacturers in the United States. Based on these returns an estimate has been made by Ernest F. Burchard, of the U. S. Geological Survey, of the entire output for the year. It is believed that this estimate is within 2% of the exact quantity of portland cement manufactured in 1911. There was apparently a slight increase in the production of 1911 over that of 1910, amounting to about 1,300,000 bbl., approximately 77,877,236 bbl. having been made in 1911 as compared with 76,549,951 bbl. in 1910. This represents an increase of only 1.7% as compared with the increase of 17.7% that occurred in 1910 over the previous year. The figures for 1910 and 1911 are so close that when complete returns are received possibly a slight decrease in production may be shown. The average factory price per barrel not including packages was 86.7c. in 1911 as compared with 89.1c. in 1910, a decrease of 2.4c. per barrel or 2.68%.

According to returns received there were decreases in production in the following districts: Lehigh, Kentucky and southern Indiana and in the Great Plains and Mountain States. The increases recorded were in New York, Ohio and western Pennsylvania, Michigan and northeastern Indiana, Illinois and northwestern Indiana, the Southeastern States, Iowa and Missouri, and in the Pacific Coast States. Slightly better prices were realized in the Lehigh District, New York, and on the Pacific Coast, but in Michigan and northeastern Indiana, Illinois and northwestern Indiana, and in the Great Plains and Mountain States the average price was lower than in 1910, but in western Pennsylvania and Ohio, southern Indiana and Kentucky, the southeastern States, and in Iowa and Missouri the price remained about the same.

Panama Canal Excavation during January totaled 2,641,444 cu.yd.; a daily average of 101,594 cu.yd. for each of the 26 working days. The rainfall for the month was 0.22 in. During the month 107,381 cu.yd. of concrete were laid and 476,130 cu.yd. of fill placed in dams.

Reform of the United States Patent system is urged in a series of resolutions adopted, Nov. 24, 1911, by the Inventors Guild, of which Mr. Ralph D. Mershon, of 60 Wall St., New York City, is President and Mr. Thomas Robins is Secretary. The resolutions, which are addressed to President Taft, urge the appointment of a committee to investigate the existing patent situation and plan for the institution of reforms.

The resolutions in part, are as follows:

Whereas: It is a well known fact that modern trade combinations tend strongly toward constancy of processes and products, and by their very nature are opposed to new processes and new products originated by independent inventors, and hence tend to restrain competition in the development and sale of patents and patent rights; and consequently tend to discourage independent inventive thought, to the great detriment of the nation, and with injustice to inventors whom the constitution especially intended to encourage and protect in their rights.

And, Whereas: Under existing methods of trying patent causes, an inventor-patentee of average means could not, at his own expense, carry to a conclusion an average patent litigation against a wealthy opponent, and therefore a few wealthy concerns usually acquire nearly all important patents in their field, to the great damage of the nation because of the restraint of competition and because of the resulting tendency of such inventors to seek protection for their inventions by trade secrets or else to cease inventive work.

And, Whereas: Efficient protection by patent of new and useful inventions would offer to the average American manufacturer one of the best methods of meeting foreign competition and would, in addition, improve quality, reduce first cost, and stimulate fair competition, with resulting benefit to the entire nation.

Resolved: The Inventors Guild composed exclusively of independent and experienced inventor-patentees, does hereby respectfully ask the attention of the President of the United States to the urgent need of reforms in the Patent Office, and also in the courts which hear and decide patent causes; and hereby requests the President to recommend to Congress the advisability of appointing a committee to confer with experienced and representative inventors with the object of promptly accomplishing such reforms as will result in more effectively carrying out the intention of the constitution; and to supplement such recommendations by such executive action as in his judgment seems likely to assist in accomplishing the needed reforms.

Town Planning Projects at Sheffield, England, embraced 4209 acres, or nearly one-fifth of the total area of the city, on Mar. 25, 1911, the date of the last published report of Charles F. Wike, City Engineer and Surveyor. There are five of these areas, ranging in size from 104 to 1721 acres. The projects have been entered upon under the British Town Planning Act of 1909, which authorizes any municipality to map its whole area into developed and undeveloped terri-

tory and after complying with formal requirements and securing the approval of the local Government board to proceed with the laying out of streets, open places, etc., in one or more of the undeveloped areas. Mr. Wike states that Sheffield has one of the largest city areas in the United Kingdom. Of its total of 23,662 acres, about 5000 acres are densely populated, 2500 acres sparsely built and 11,500 acres available for further development. The remaining areas consist of "moorland, reservoirs, parks, recreation grounds, precipitous grounds, etc., unavailable for buildings."

Sewage Sludge at Sheffield, England. is not greatly in demand for fertilizing purposes. According to City Engineer and Surveyor Charles F. Wike, only 342 long tons were taken away by farmers in the years 1910-11, as compared with 59,815 tons "sent to the pit at Kilnhurst." During the years mentioned, 8.97 long tons of sludge were produced from a total volume of 6,701,403,000 imp. gal. of sewage treated. When the report was written, it was expected that by the time it was printed the old chemical precipitation works at Sheffield, established in 1886, would have entirely given place to new plain sedimentation tanks and contact beds, some which were already in use.

Personals

Mr. Aaron Johnston has been appointed Principal Assistant Engineer of Maintenance-of-Way of the Florida East Coast Ry.

Mr. F. H. Davis, business partner of the late Edwin Hawley, has been elected Vice-President of the Chicago & Alton R.R., succeeding Mr. Hawley.

Mr. Allen T. Paine, Assistant Engineer of the New York State Highway Department, has resigned to accept a similar position with the Coleman Du Pont Road, Inc., of Delaware.

Mr. S. L. Fuller, formerly President and General Manager of the Friday Contracting Co., of Pittsburg, Penn., has been made General Superintendent of the C. M. Neeld Construction Co., Oliver Bldg., Pittsburg, Penn.

Mr. L. S. Shaw, formerly Construction Superintendent for J. G. White & Co., Inc., New York City, has accepted a position with the Westinghouse Machine Co., of East Pittsburg, Penn., and will be connected with the Chicago office of the company.

Messrs. Fletcher & Anglada, Automobile Engineers, of 50 Church St., New York City, have dissolved partnership. Mr. Anglada will continue the business in his own name at the same address and Mr. Fletcher will become associated with the Walter Motor Truck Co.

Mr. David W. Stradling, formerly Assistant Engineer with the City Engineer of Indianapolis, Ind., has been appointed Assistant Professor of Civil Engineering at the University of Kansas, Lawrence, Kan. Mr. Stradling will have charge of the course in Railway Engineering.

Mr. C. W. Powers, formerly Resident Engineer of the Grand Trunk Ry., at Toronto, Ont., has been appointed Bridge Engineer of the City of Toronto, succeeding Mr. E. L. Cousins. The salary of this position is $2400 per annum, with an annual increase of $100 until a maximum of $3000 is reached.

Messrs. F. P. Gutelius, M. Am. Soc. C. E., General Superintendent of Transportation of the Canadian Pacific Ry., and George Lynch-Staunton, a lawyer of Hamilton, Ont., have been appointed a commission to inquire into the cost of construction of the Trans-Continental Ry. of Canada. The fundamental object of the investigation is to determine the reason for discrepancy between the original estimates and actual cost of work.

Mr. C. W. Reinhardt, who has been for 20 years head of the drafting and illustrating department of Engineering News, has resigned his position and opened an office for the preparation of drawings, photographs, etc., for photo-reproduction, at 120 Liberty St., New York City. Besides his work on Engineering News, Mr. Reinhardt is well known as the author of "Reinhardt's Lettering," "The Technique of Mechanical Drafting" and other books for draftsmen.

Mr. Charles G. Elliott, M. Am. Soc. C. E., Chief of the Drainage Investigation Bureau of the Department of Agriculture, and Mr. A. D. Morehouse, Office Engineer of the Bureau, were dismissed by Secretary Wilson on Feb. 3 on advice of Solicitor McCabe, of the Department. According to a statement made by McCabe, these engineers in June, 1909, found the appropriation under which they were working insufficient to meet the payrolls for the current month—the last one of the fiscal year. They deemed it important that the work should continue uninterrupted and as the law forbids the use of any part of one year's appropriation to pay for work done during another fiscal year, certain citizens interested in the work advanced the money to meet the June payroll, and were later reimbursed by receiving temporary appointments, lasting for a month or so, during which they received payment without rendering corresponding service.

This action was taken by Messrs. Elliott and Morehouse for the benefit of the work on which they are engaged and they state that it was done after being submitted to and approved by Mr. F. E. Singleton, the Department accountant. None of the persons concerned benefited a penny by the transaction, nor did the Government pay for any work not actually performed for its benefit. Their effort to untie Government red tape in the interest of efficiency, however, cost the two engineers their positions.

Obituary

James M. Fotheringham, Assoc. M. Can. Soc. C. E., District Engineer of the Grand Trunk Pacific Ry., died in Quebec, Que., on Feb. 6.

George Jarvis Brush, Professor Emeritus, and formerly Director of the Sheffield Scientific School, Yale University, died in New Haven, Conn., on Feb. 6. Prof. Brush was born in Brooklyn, N. Y., on Dec. 15, 1831, and 21 years later graduated from Yale University as a Bachelor of Philosophy. He then went abroad and studied at the University of Munich, the Royal Saxony School of Mines and the Government School of Mines at London, returning to this country in 1855. From that time until 1898—33 years—he was Professor of Metallurgy and Mineralogy at Sheffield Scientific School, and for 27 years, 1872 to 1899, he was Director of the school. For many years he was one of the best known scientists and mineralogists in this country and was a member of learned societies, both here and abroad. He received an honorary degree of A. M. from Yale University in 1857, and an LL. D. from Harvard University in 1886. He was President of the American Association for the Advancement of Science in 1880, and was the author of many articles on mineralogy. Three daughters survive him

Engineering Societies

COMING MEETINGS

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 20. Annual meeting at New York City. Secy., Jos. Struthers, 29 West 39th St., New York.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting at Davenport, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Mar. 4-6. Annual meeting at Chicago, Ill. Secy., Will P. Blair, 824 Engineer's Bldg., Cleveland, Ohio.

ILLINOIS WATER SUPPLY ASSOCIATION.
Mar. 5-6. Annual meeting at Urbana, Ill. Secy., E. Bartow, Urbana, Ill.

NATIONAL BRICK MANUFACTURERS ASSOCIATION.
Mar. 6-9. Annual convention at Chicago, Ill. Secy., T. A. Randall, Indianapolis, Ind.

CANADIAN MINING INSTITUTE.
Mar. 6-8. Annual meeting at Ottawa, Can. Secy., H. Mortimer Lamb, Room 3, Windsor Hotel, Montreal, Can.

NATIONAL ASSOCIATION OF CEMENT USERS.
Mar. 11-16. Annual convention at Kansas City, Mo. Secy., Edward E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN BOILER MANUFACTURERS ASSOCIATION.
Mar. 12-15. Annual convention at New Orleans, La. Secy., J. D. Farasey, East 37th St. and Erie R.R., Cleveland, Ohio.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 19-21. Annual meeting at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.
Mar. 28-29. Annual meeting at New York City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

NATIONAL DRAINAGE CONGRESS.
April 10-13. Annual meeting at New Orleans, La. Vice-President, E. T. Perkins, First National Bank Bldg., Chicago.

AMERICAN ELECTROCHEMICAL SOCIETY.
Apr. 18-20. Annual meeting at Boston, Mass. Secy., Jos. W. Richards, Lehigh University, So. Bethlehem, Penn.

National Electric Light Association—The annual meeting will be held June 10-14 in the State Armory at Seattle, Wash. We are informed by Secretary T. C. Martin, 29 West 39th St., New York, that the association's present membership is more than 10,600. This indicates a gain of about 1400 members in the past six months.

Cleveland Engineering Society—At the regular meeting held in the Chamber of Commerce Bldg., Feb. 13, Dean Mortimer E. Cooley, of the Engineering Department of the University of Michigan, presented a paper entitled "Public Utilities and Their Relation to the Public." At the meeting to be held on Feb. 27, Prof. J. F. Barker, of the Cleveland Technical High School, will present a paper on "Technical Education."

American Society of Civil Engineers—The San Francisco Association of members of this society has elected officers for 1912 as follows: President, C. E. Grunsky; Vice-President, C. H. Snyder. The Secretary is E. T. Thurston, 713 Mechanics Institute, San Francisco.

At the regular bi-monthly meeting, Feb. 16, Chief Engineer O. C. Merrill, of the U. S. Forest Service, will address the association on "Water-Power Development under Government Control."

American Society of Engineering Draftsmen—At the regular monthly meeting, to be held at the Engineering Societies' Building, New York City, Feb. 15, papers will be presented on "The Training of Draftsmen," by Prof. F. G. Higbee, of Iowa State University, and "Some Common Faults of Draftsmen," by William F. Turnbull, of the American Locomotive Co.

American Road Builders Association—The annual meeting was held, Feb. 3, in New York City. Officers for the coming year were elected as follows: President, Nelson P. Lewis, New York; Vice-Presidents, Harold Parker, Worcester, Mass.; J. D. Meriwether, Socorro, New Mexico, and W. A. McLean, Toronto, Canada; Secretary, E. L. Powers, New York City; Treasurer, W. W. Crosby, Baltimore, Md.

Maine Society of Civil Engineers—At the annual meeting, held Feb. 7, at Lewiston, Maine, officers were elected as follows. President, Walter H. Sawyer, Lewiston, Maine; Vice-President, Prof. Harold S. Boardman, Orono, Maine; Secretary and Treasurer, Frank E. Pressey, Bangor, Maine. Directors: Cyrus C. Babb, Augusta, Maine; E. E. Greenwood, Skowhegan, Maine; C. A. Mixer, Rumford, Maine; J. C. Stevens, Portland, Maine, and E. C. Jordan, Portland, Maine.

Permanent Exhibit of Railway Supplies—A permanent manufacturers' exhibit of railway supplies and equipment has been established in the Karpen Bldg., Chicago. In connection with the permanent exhibition, large assembly and committee rooms will be provided for the free use of railway associations. There is also a large and well-furnished club room. These rooms and the exhibition hall occupy at present the 12th floor comprising about 26,000 sq.ft. The Secretary is Mr. Francis H. Quail, 900 So Michigan Blvd., Chicago, Ill.

International Road Congress — The third International Road Congress will be held in London, England, in June, 1913. The first congress was held in Paris in 1908, and the second, in Brussels in 1910. Membership is open to all, and forms of application for membership can be obtained from the Honorary Secretary, Mr. Rees Jeffreys, Road Board Offices, Queen Ann Chambers, Westminster, S. W. The membership fee of $5 entitles the subscriber to take part in all proceedings and excursions and to receive a copy of the full report of the discussions and decisions of the congress, together with a set of the papers presented at the various sessions.

International Congress for the Prevention of Accidents and Industrial Hygiene—This congress, organized by the French, Belgian and Italian private associations for the prevention of accidents, will meet at Milan, Italy, May 27-June 1, 1912. The international committee in charge of preparations includes representatives from Italy, France, England, Belgium, Germany, Austria, Switzerland and Holland. The chairman of the American committee is Wm. H. Tolman, Director of the American Museum of Safety, 29 West 39th St., New York. Membership in the American section can be secured by paying a fee of $5, which entitles the subscriber to all the privileges of the congress and to a copy of the "Proceedings."

Iowa Engineering Society—The program of papers to be presented at the 24th annual meeting at Davenport, Iowa, Feb. 21-23, includes the following: "Concrete Pavements in Davenport and Vicinity," A. M. Compton; "Concrete Roadways," J. H. Chubb, Universal Portland Cement Co.; "Concrete Pavements with Bituminous Top Coat," N. H. Tunnicliff. Committee reports will be presented on Railroad Engineering, by S. N. Williams; Sanitary Engineering, A. Marston; Minimum Highway Bridge Specifications, James B. Marsh; Roads and Pavements, T. H. MacDonald, and Legislation, by Paul Beer.

On Feb. 24, the members of the society will visit the Hydro-Electric Plant of the Mississippi River Power Co. at Keokuk.

Ohio Water Works Association—An organization under this name was effected at a meeting held at Columbus, Ohio, Jan. 24-25, by representatives of 43 privately owned water-works of that state. Officers were elected as follows: President, C. W. Wiles, Delaware Water Co.; Vice-President, W. H. Sharp, Ashtabula Water Supply Co.; Secretary and Treasurer, F. C. Jeannot, Marysville Light & Water Co., Marysville, Ohio. The executive committee is made up of the president and secretary and three other members as follows: J. M. Henry, Ashtabula Water Supply Co.; R. P. Bricker, Shelby Water Co., and A. W Inman, Massillon Water Supply Co.

Membership is open to "every officer, manager and superintendent of any water-works plant under private ownership, within the state of Ohio," upon payment of a single membership fee ($2) by the owner of the plant. The purpose of the association, as given in the by-laws, is the "mutual help of members and exchange of information and ideas on the management and operation of water-works plants."

The members will attend the Central States Water Works Association convention at Detroit, and will hold at least one meeting of their own at that convention for discussing matters of special interest to privately owned water-works.

The Kansas Engineering Society—The second annual meeting was held at the Agricultural College, Manhattan, on Jan. 23 and 24.

The new road law of Kansas requires that the public highways be classified according to their utility and relative importance as state roads, county roads, mail routes and township roads. State roads are roads designated as such by the legislature. County roads are designated by the county commissioners and are to be highways connecting cities and market centers and must be made as nearly continuous from one county to the next as possible. Mail routes are roads used by the postal service which have not been designated as state or county roads. All other public highways are known as township roads.

The state and county roads are constructed and maintained at general county expense under the direct supervision of the county commissioners and county engineer. The mail-route and township roads are constructed and maintained at township expense under the supervision of the township highway commissioners and the county engineer. Messrs. W. S. Gearhart, H. A. Rowland, C. C. Huntington, Fred R. Hesser and E. E. Clark presented papers on "How Roads Should be Classified and How the Different Classes Should be Constructed and Maintained." The general consensus of opinion was that the new law gives the most equitable distribution of the cost of constructing and maintaining public highways Kansas can have until the state is permitted to do internal improvement work. Also that the system of administration is commendable and that if the county commissioners use good judgment in selecting their county engineer and in organizing their road forces, the state and county roads can be made model highways reaching every community throughout the state.

In discussing plain monolithic concrete retaining walls such as are used in track-elevation work where the walls are heavily surcharged, J. M. Meade, of the Santa Fé Ry., recommended that the width of base be made 0.65 of the height with a top width of not less than 18 in. He cited a number of costly failures where a width of only 0.45 had been used. For reinforced-concrete walls he stated it was common practice to use 0.6 of the height for the base width.

Among the most interesting and valuable papers presented was one on "Field Methods, Office Practice and Supervision and Inspection of Paving Work in Topeka," by Messrs. A. R. Young, E. G. Gibson and C. A. Forter. In a report on "Inverted Siphons in Street Drainage," L. E. Curfman stated he was not a strong advocate of their use. However, there are cases where they can scarcely be avoided and with a little attention they can be kept in good condition and by the use of oil no trouble would be experienced from mosquitoes.

A paper presented by C. C. Witt on the work of the Engineering Department of the Public Utilities Commission was especially interesting and brought out a good discussion. Clinton S. Burns, in a paper on "The Management of City Utilities and Their Valuation," ably discussed the fundamental principles of making public utility valuations. The velocity of the flow of the Kansas River was treated in a paper read by V. R. Parkhurst. In a paper presented by W. J. Arnold, he recommended that the state make careful investigation of flood protection and the conservation of the excess water.

A paper presented by S. C. Loper on "The Contamination of City Wells" dealt with a series of examinations made on fifty wells in the city of Lawrence and the deplorable condition he found in many cases.

"The Use and Abuse of Sewage Disposal Plants" was discussed by C. A. Smith. He made a strong plea for the members of the Society to aid the State Board of Health.

The retiring President, W. C. Hoad, gave an address on "The Spirit of Public Service in Engineering." He believes the cultivation of the spirit of disinterested service will bring its sure reward to the profession as a whole as well as to the individual members of it; that it is this rather than by the machinery of legislation or by the devices of the labor union that the standing of the profession and its reputation with the public can be most surely advanced.

The election of officers resulted as follows: President, R. V. Leeson, Topeka; Vice-President, J. M. Meade, Topeka; Secretary-Treasurer, W. S. Gearhart, Manhattan.